1976
Scorpion
Range Whip

Service Manual

Engine Section

ENGINE SYSTEM

Functional Description:

2-CYCLE ENGINE FUNDAMENTALS

The Cuyuna 2-cycle air-cooled gasoline engine, particularly the axial fan-cooled twin cylinder engine, has become very popular today for snowmobiles. It is uniquely qualified for this application because of its high power output, light weight and ease of lubrication, with fewer moving parts than other conventional 2-cycle and 4-cycle engines.

However, in order to get the best possible use and ensure that it retains its high degree of dependability and endurance, it must receive proper care and maintenance. Therefore, it is necessary for us to know something about the basic fundamentals of this engine and how it functions.

OPERATION

The Cuyuna 2-cycle Twin Cylinder engine is of the loop-scavenged third port type, the most widely used design today. It uses a mixture of gasoline, oil and air for combustion, lubrication and cooling. It fires on every stroke of each piston. There are two power strokes for every revolution of the crankshaft.

As the piston moves upward in the cylinder it draws the fuel/air mixture into the crankcase through the intake manifold while at the same time compressing fuel that has been forced into the combustion chamber. See Fig. 1-1A.

As the piston nears top dead center the spark plug is fired and the compressed fuel/air mixture burns and expands thereby forcing the piston downward on a power stroke.

As the downward stroke of the piston turns the crankshaft, it also starts to compress the fuel/air mixture in the crankcase and, simultaneously, opens the exhaust port and closes the intake port. See Figs. 1-1 B & C.

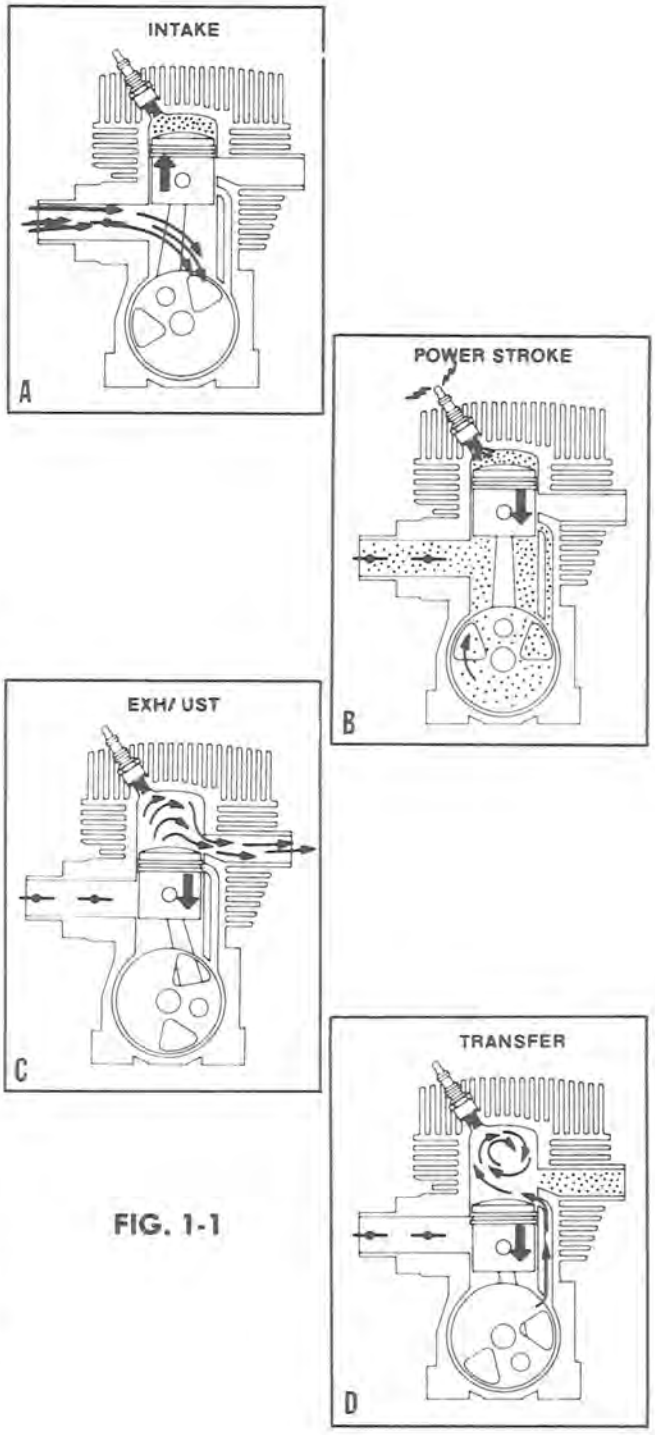


FIG. 1-1

After the exhaust port is fully open and the intake port is fully closed, further piston travel starts to open the transfer ports. The compressed fuel/air mixture from the crankcase then travels up the transfer ports and into the combustion area.

After most of the burned exhaust gases have left the cylinder, an incoming charge of fuel/air mixture scavenges the combustion area giving it a fresh charge and the cycle is then repeated. See Fig. 1-1 D.

Because lubrication is dependent on the mixing of oil and fuel, it is extremely important that good quality oil and gasoline are properly mixed. The proper ratio of oil to gasoline will prevent possible engine overheating, piston or cylinder scoring, or eventual engine seizure. Too much oil and not enough gasoline can lead to incomplete combustion, fouled plugs, carbon build-up and muffler clogging.

EXHAUST SYSTEMS

SELECTION

Selection of an exhaust system (including exhaust manifold, intermediate pipes, elbows and muffler), is a result of thorough test procedures involving measurement of fuel consumption, horsepower and noise level. Contrary to popular belief, the exhaust system is not only for quieting the engine, but also serves to increase horsepower output. Changes made to the original equipment exhaust system by changing any component in the system can result in loss of power and/or severe engine damage. For these reasons, intermediate lengths of pipe betweeen the cylinder and the muffler are particularly critical.

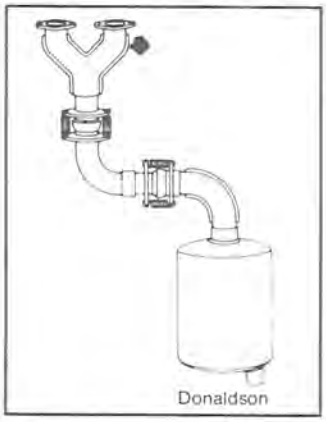
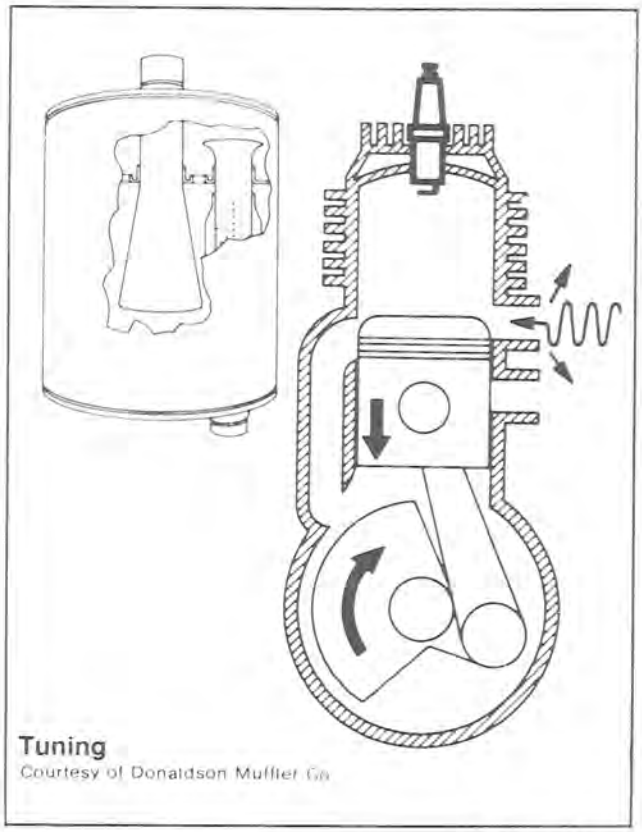


FIG. 1-2

TUNED MUFFLERS

Tuned mufflers allow the engine to exhaust its spent charge into an adequate volume and properly matched muffling system. More important, the mufflers that are tuned, incorporate designs that suck the exhaust gas from the cylinder allowing fuel and air to rapidly replace it and also "cram" over-scavenged fuel and air mixture from the exhaust pipe back into the cylinder using sound waves and sound energy. This is accomplished at the speed of sound which allows the engine to produce higher torque at higher RPMs.



Tuning

Courtesy of Donaldson Muffler Co.

FIG. 1-3

HOW TUNING WORKS

The megaphone effect of the expanded intake tube scavenges exhaust gas from the cylinder allowing rapid replacement of the fuel/air mixture from the crankcase. Reflected sound waves and sound energy stop over-scavenging and return fuel/air mixture to the cylinder. It gives a supercharging effect even though it operates from the exhaust rather than the intake side. Over-scavenging is also retarded by moderate muffler back pressure. Silencing is accomplished after power is maximized by acoustical packing in the resonator outlet tube plus chambering and baffling which gives an effective 2-pass muffler design.

TABLE OF SPECIFICATIONS

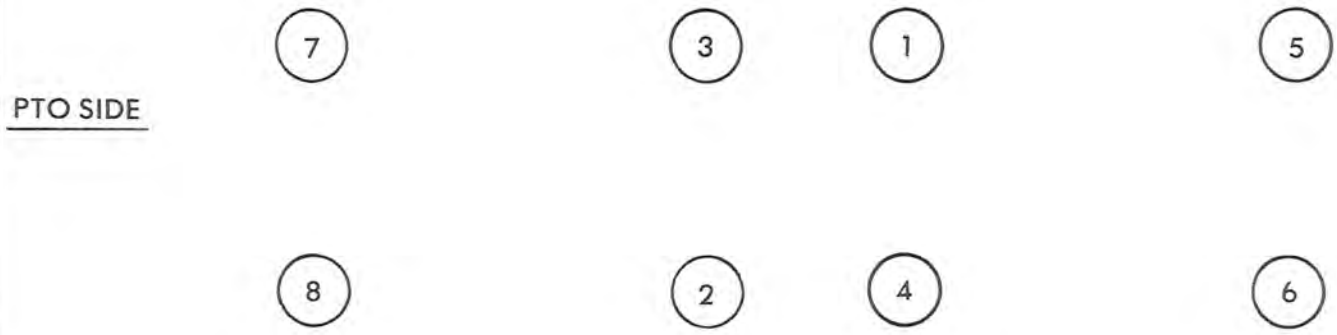
DESCRIPTION	ENGINE MODEL		
		CUYUNA 400	
BORE		2.559" (65.0mm)	
STROKE	2.362" (60mm)		
DISPLACEMENT IN cc		398	
COMPRESSION RATION (actual)		12:1	
IGNITION SYSTEM	Bosch Flywheel Magneto		
LIGHTING COIL VOLTAGE AND OUTPUT		12V 150W	
*TIMING BEFORE TDC (CENTRIFUGAL WEIGHT ADVANCED)		.102 - .112	
TIMING BEFORE TDC (CENTRIFUGAL WEIGHT RETARDED)		.018" to .020"	
BREAKER POINT GAP	.014" to .016"		
SPARK PLUG THREAD	14mm. x 1.25 - 3/4" reach		
SPARK PLUG GAP		.020" (0.5mm.)	
SPARK PLUG (ORIGINAL EQUIPMENT)		CHAMPION N-3	
TYPE OF ENGINE COOLING	Axial Flow Fan		
ROTATION OF CRANKSHAFT	Counterclockwise (PTO side)		
CARBURETOR	Walbro W F		
FUEL/OIL RATIO	As Specified on Scorpion Oil Container		
GASOLINE	95 octane, minimum (lead free not acceptable)		
TYPE OF OIL	Special 2-Cycle Snowmobile Oil		

* Do not exceed indicated advance, as this will result in severe engine damage.

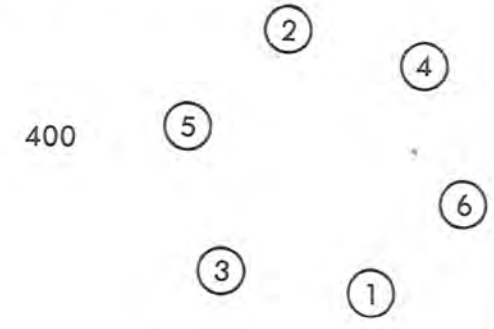
TABLE OF SPECIFICATIONS

TORQUE SPECIFICATIONS		CUYUNA 400	
CYLINDER HEAD NUTS	28-32 Ft.-Lb.	16-18 Ft. - Lbs.	
CYLINDER BASE NUTS	16-18 Ft. - Lbs.		
FLYWHEEL NUT	44-50 Ft. - Lbs.		
INTAKE MANIFOLD NUTS	16-18 Ft. - Lbs.		
FAN HOUSING SCREWS	16-18 Ft. - Lbs.		
FAN WHEEL NUT	22-24 Ft. - Lbs.		
RING GEAR SCREWS (6mm.)	6-7 Ft. - Lbs.		
RING GEAR SCREWS (8mm.)	10-12 Ft. - Lbs.		

Tightening Sequence for Cylinder Base Nuts
All Models



Tightening Sequence for:
Cylinder Head Nuts, Fan Housing, Ring Gear Flange, Intake Manifold and Recoil Starter Clamps



CUYUNA TWIN CYLINDER ENGINES

CUYUNA 400

DISASSEMBLY

A. Recoil Starter

Remove four (4) screws holding the recoil assembly to the fan housing.

See Fig. 1-4.

See pages 1-28 A, B, C for recoil starter disassembly.

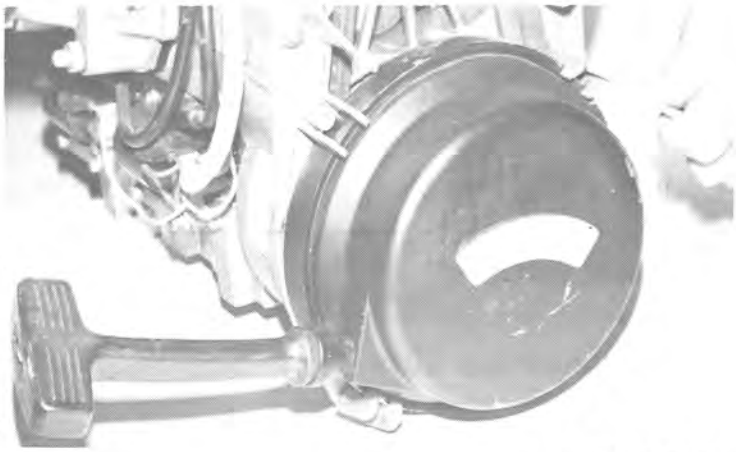


FIG. 1-4

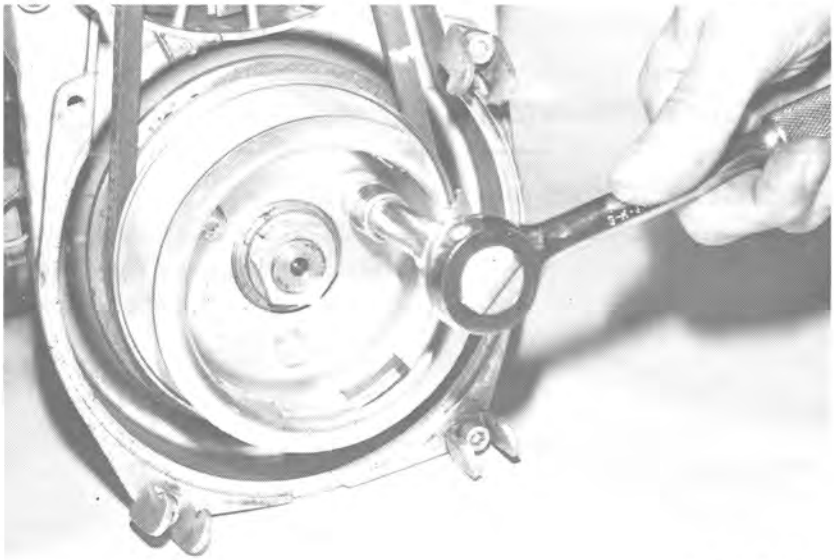


FIG. 1-5

B. Lower Fan Pulley and Carrier Assembly

Remove the three (3) hex head bolts on the carrier. Remove carrier, lower pulley assembly and V-belt. See Figs. 1-5, 1-6.

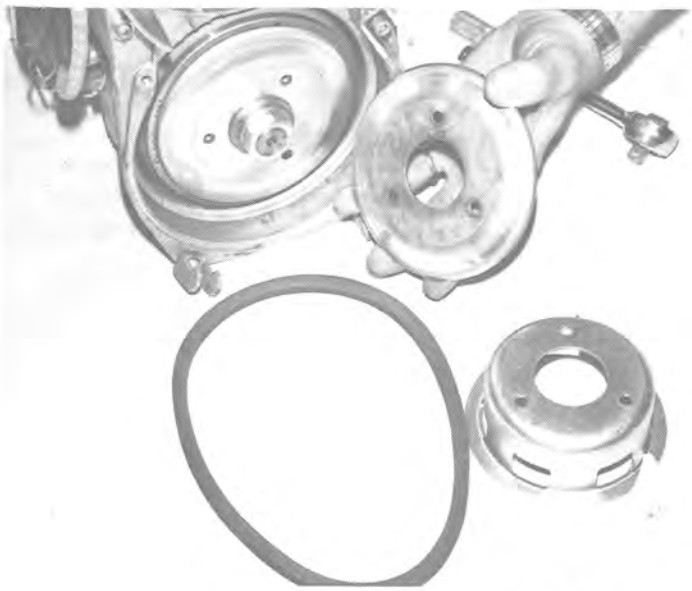


FIG. 1-6

C. Upper Fan Belt Pulley Assembly.

Insert a 3/16" drill or a suitable punch through the indexing hole into the impeller body. With a 17 mm socket wrench, remove the fan nut, lock washer, pulley halves and spacers. See Figs. 1-7, 1-8, 1-9.

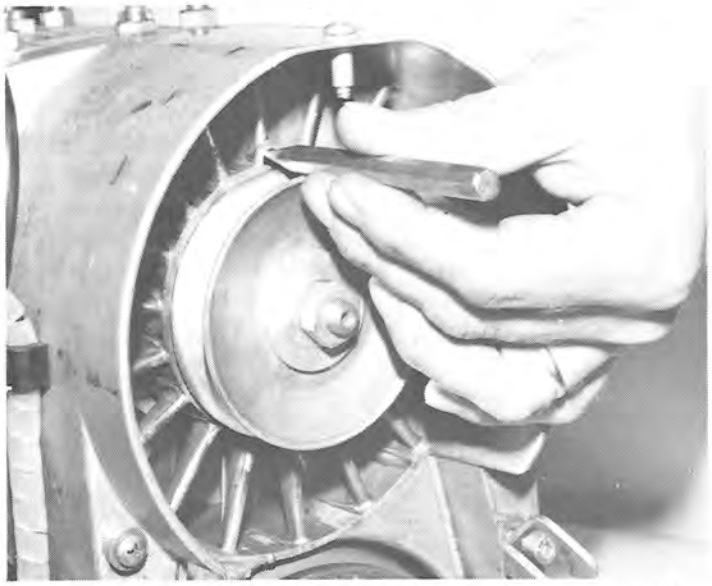


FIG. 1-7

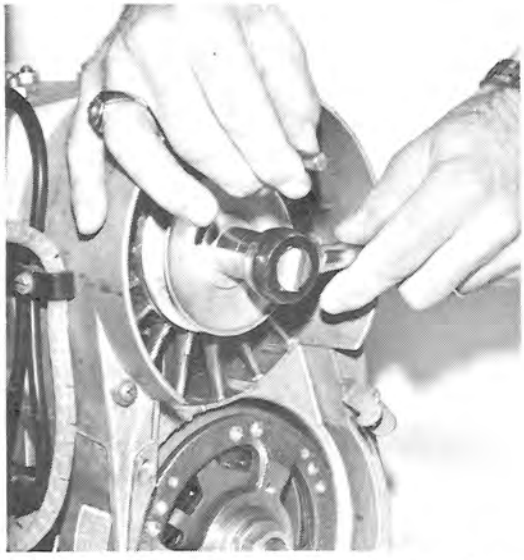


FIG. 1-8

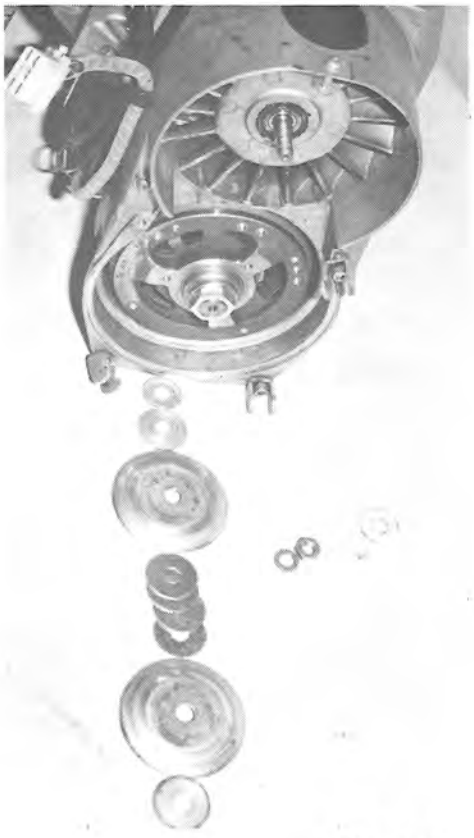


FIG. 1-9

D. Flywheel Magneto

Remove the crankshaft nut using a 27 mm socket wrench. Pull the flywheel by attaching flywheel puller 444-31-843-2 to the flywheel flange using bolts provided. Screw the three bolts through the puller into the flange and tighten evenly. With a socket wrench, tighten the puller bolt until the flywheel loosens on the crankshaft. See Figs. 1-10, 1-11, 1-12, 1-13.

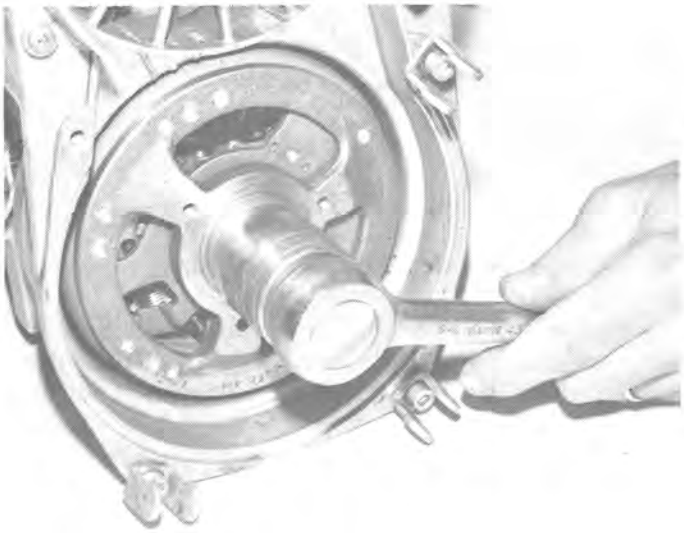


FIG. 1-10

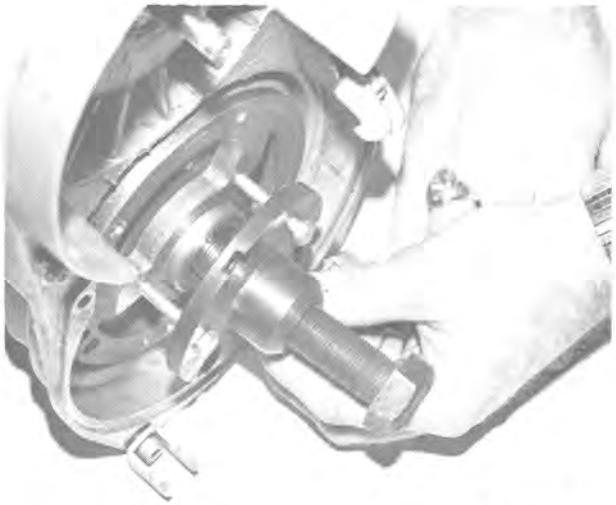


FIG. 1-11

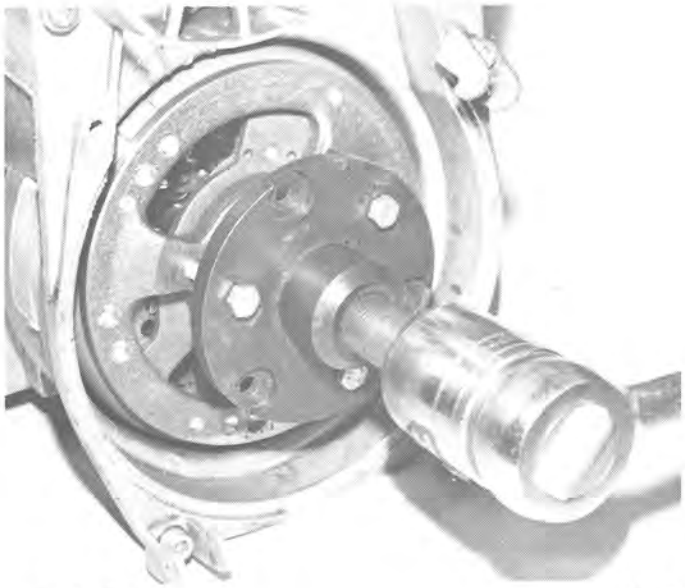


FIG. 1-12

NOTE: It is important that care be taken in removing the flywheel assembly because the positioning key located in the keyway may stay in its original position and thereby cause damage to the advance mechanism. A small icepick or screwdriver may be used to loosen and remove the key.

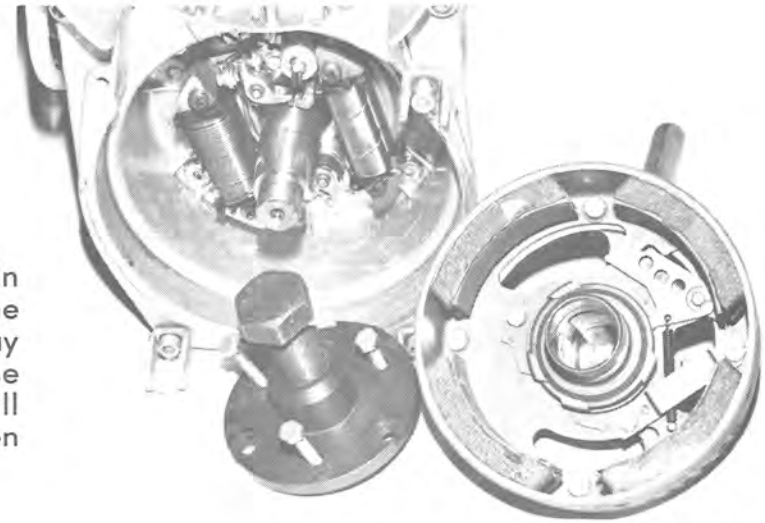


FIG. 1-13

E. Intake Manifold Assembly

Remove the four (4) intake manifold nuts and washers. Remove manifold assembly and insulators. See Figs. 1-14, 1-15.

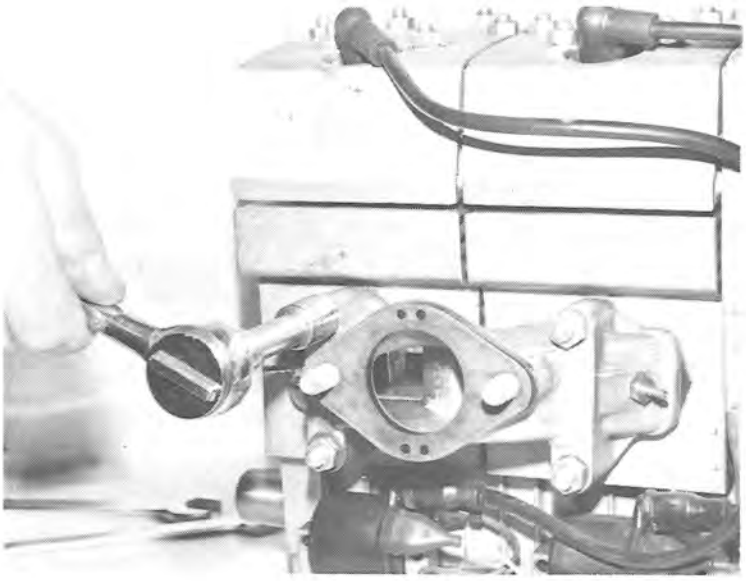


FIG. 1-14

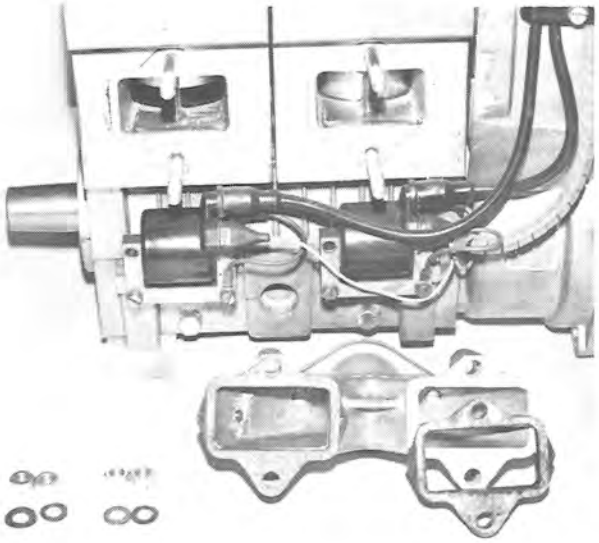


FIG. 1-15

F. Fan Housing and Armature Plate Assembly

Remove screw holding spark plug wire bracket to fan housing. With a socket type 5 mm Allen wrench and impact driver, remove the four (4) mounting bolts holding fan housing to crankcase. (See Fig. 1-16). Remove fan housing from crankcase (See Fig. 1-17).

FIG. 1-16

Unplug connector housing coil wires. (Note color coding of wires.) Remove armature plate assembly and wires, as a unit, from fan housing.

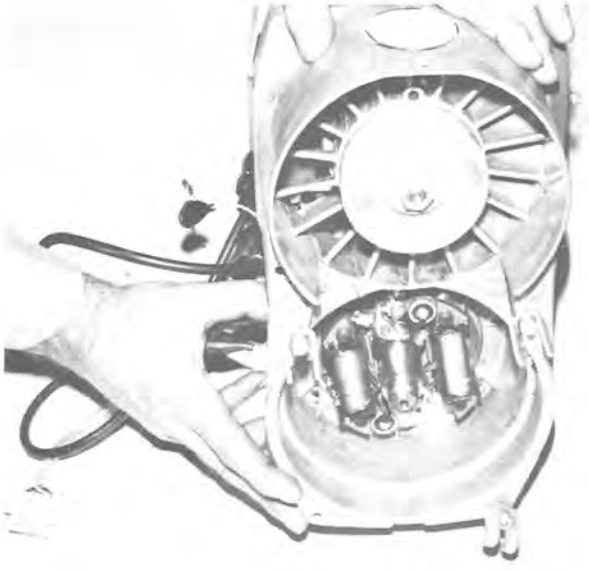


FIG. 1-17

Remove the fan by tapping the end of fan shaft with a soft hammer. With a flat punch and hammer, tap the inner race of the furthest bearing in the housing. See Figs. 1-18, 1-19, 1-20.

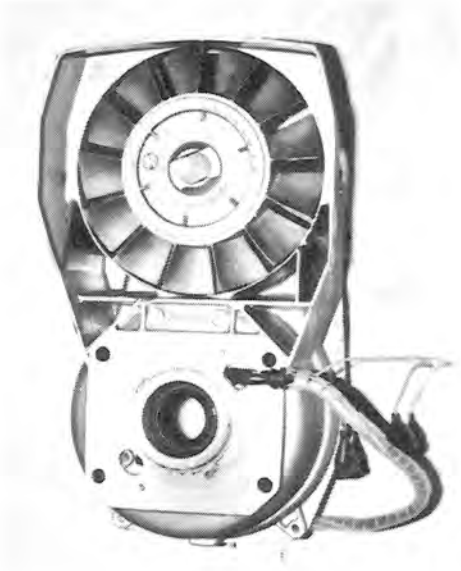


FIG. 1-18

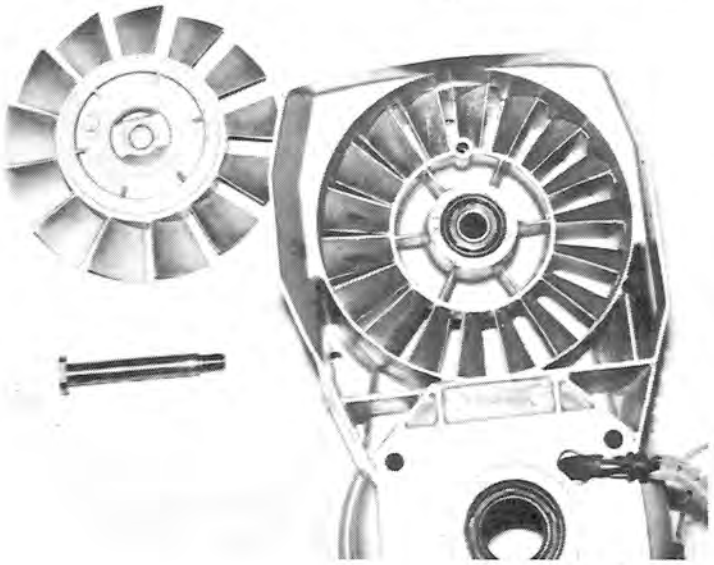


FIG. 1-19

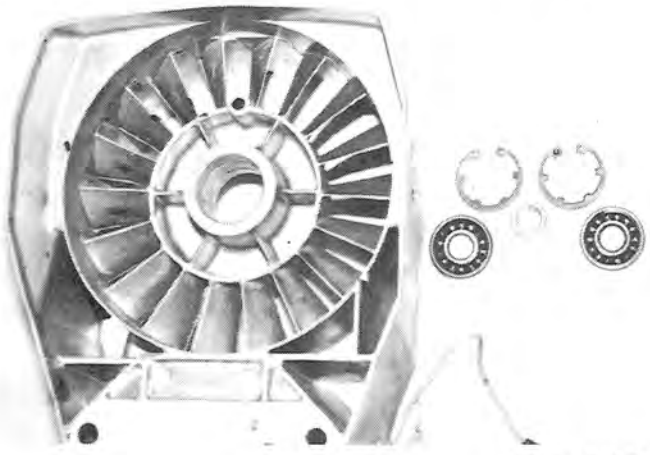


FIG. 1-20

G. Remove spark plugs with spark plug wrench. (See Fig. 1-21.)

H. Cylinder Heads

Remove cylinder head nuts with a 13 mm socket wrench. Mark cylinder heads before removal from cylinder. Remove and discard gaskets. See Fig. 1-22.

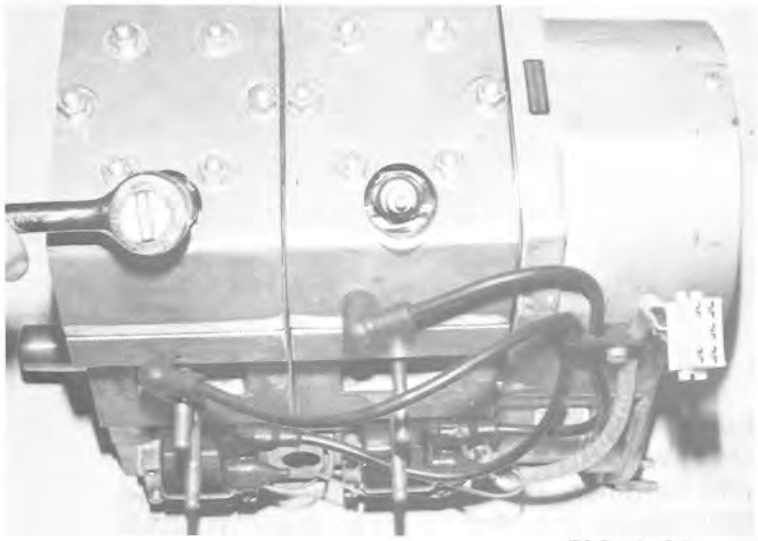


FIG. 1-21

I. Cylinders

Remove the eight (8) cylinder base nuts using a 13 mm socket wrench and remove the eight (8) spring washers. The cylinders may be removed. See Fig. 1-23.

NOTE: IMPORTANT

If removal of cylinders only is required, care must be taken that the crankcase seal is not disturbed. The removal of the PTO cylinder will allow the placement of two bolts and nuts with flat washers to apply constant pressure to crankcase assembly. Bolts should be placed in the center two holes (adjacent to the fan side cylinder). See Fig. 1-31. The second cylinder may now be removed.

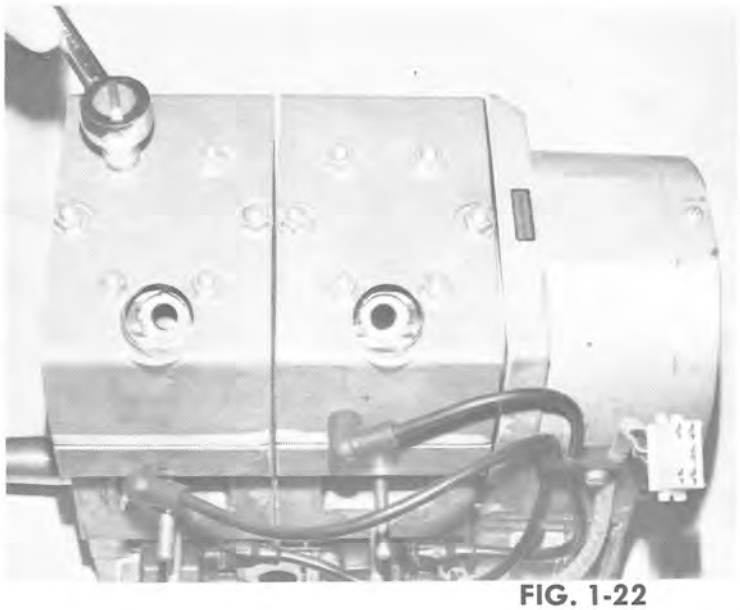


FIG. 1-22

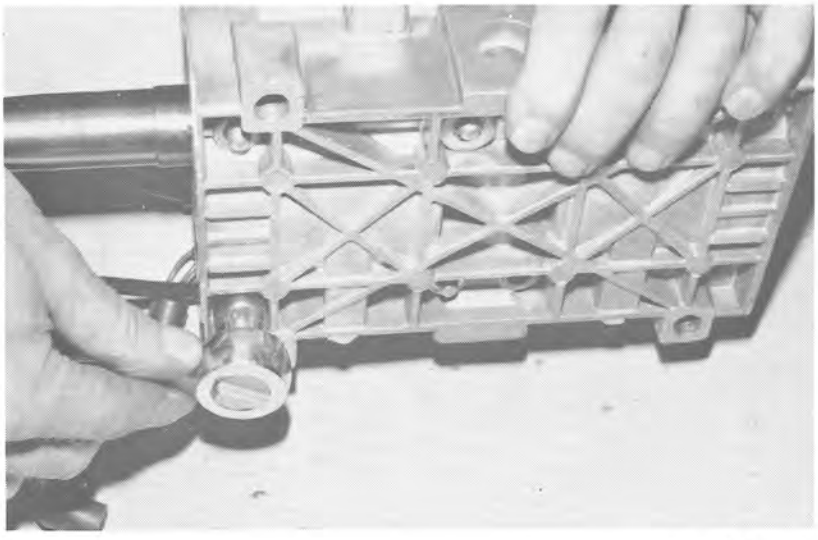


FIG. 1-23

J. Piston and Wrist Pin

With needle nose pliers, remove circlips from pistons. Heat the piston with a heat gun or propane torch. Heat only to the point where piston may still be held in hand. Push the pin out.

K. To separate the crankcase halves, hold upper portion of crankcase assembly in one hand, lifting slightly and tap the end of the crankcase with a soft hammer. The crankcase will separate and the crankcase may be removed. See Fig. 1-24.

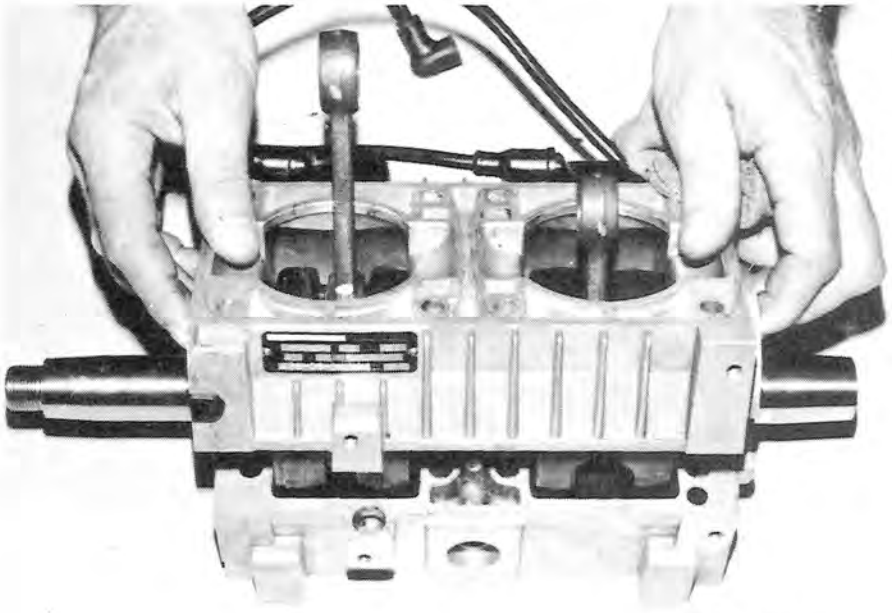


FIG. 1-24

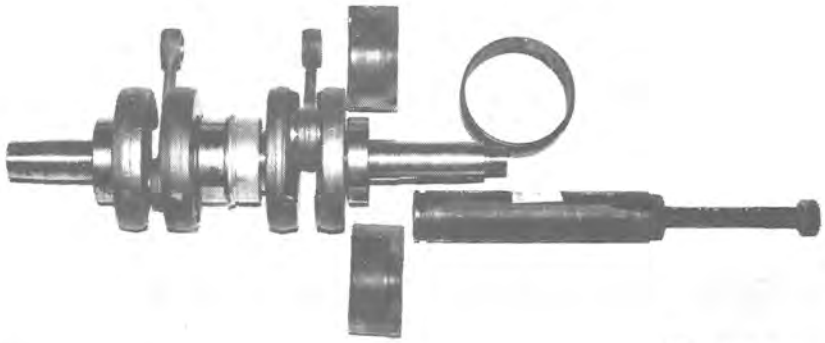


FIG. 1-25

L. Crankshaft Bearings

To remove crankshaft end bearings, use bearing puller 444-31-807-0. See Figs. 1-25, 1-26, 1-27. Slip the puller half shells around the outer bearing race and around puller assembly. Slide the retaining ring over the half shells. Using two (2) 27 mm wrenches, turn the center bolt clockwise with one wrench and use the second wrench to hold the puller body. Before removing the PTO side crankshaft bearing, insert a 1/2" 20 UNF bolt, 1/2" long, to protect the internal thread of the crankshaft.

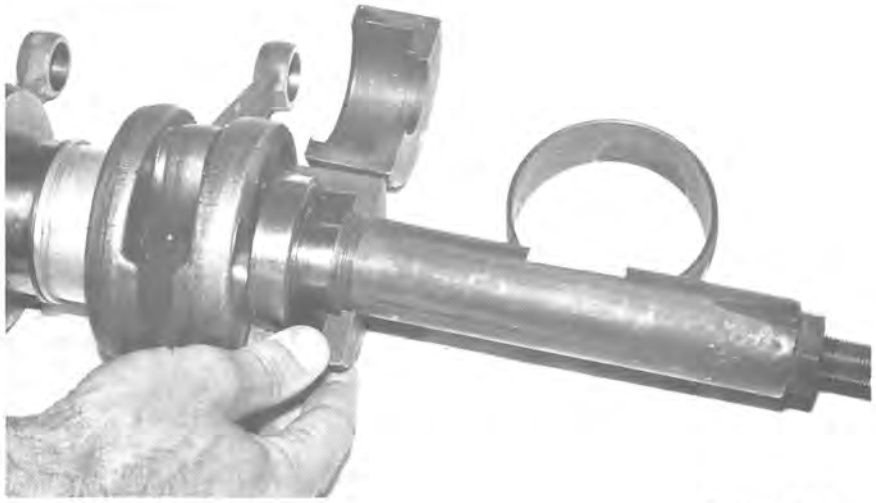


FIG. 1-26

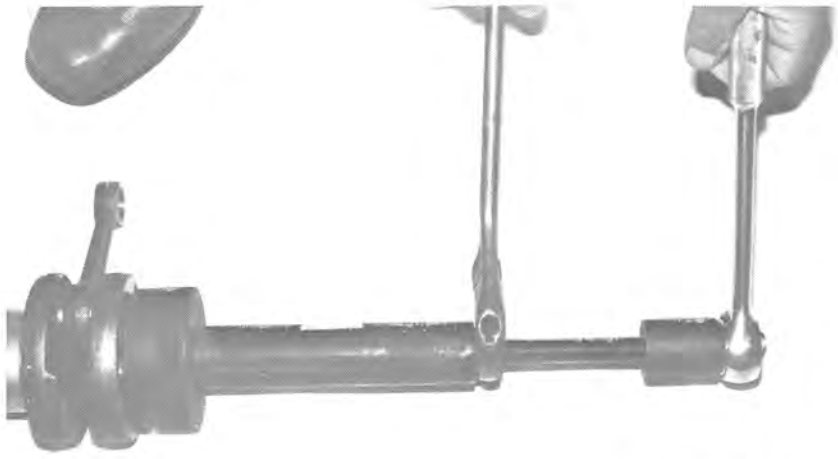


FIG. 1-27

ASSEMBLY

A. Crankshaft Bearings.

Heat crankshaft bearings in oil (or oven) to approximately 180 degrees.

Slide bearing on crankshaft.

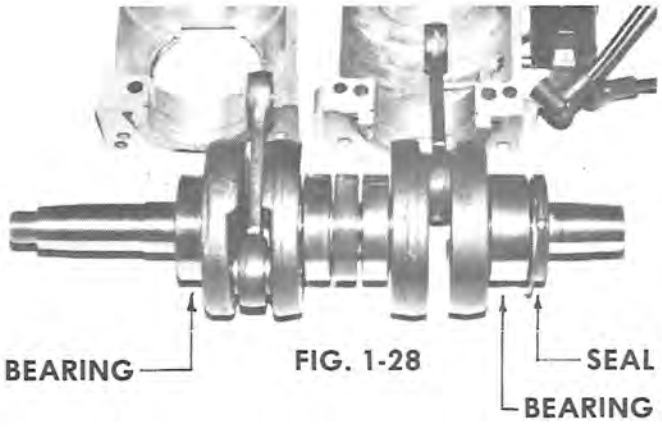


FIG. 1-28

B. Crankcase.

Inspect and clean both halves of crankcase. The proper sealant material such as Permatex Hy-Tack Spray should be now sprayed on crankcase sealing surfaces. See Fig. 1-29. Before installing crankshaft into crankcase lower half of it will be necessary that all bearing outer surfaces be wiped clean of foreign material so that proper sealing will occur. After installing PTO thrust washer and oil seal (inside groove of oil seal coated with light grease) place the crankshaft carefully into the lower crankcase half and properly position all components. See Figs. 1-30. Placement of the upper crankcase half may now be made. Be certain that the center seal is lined up with the crankcase split line.

Tap upper crankcase half to seat with lower half.

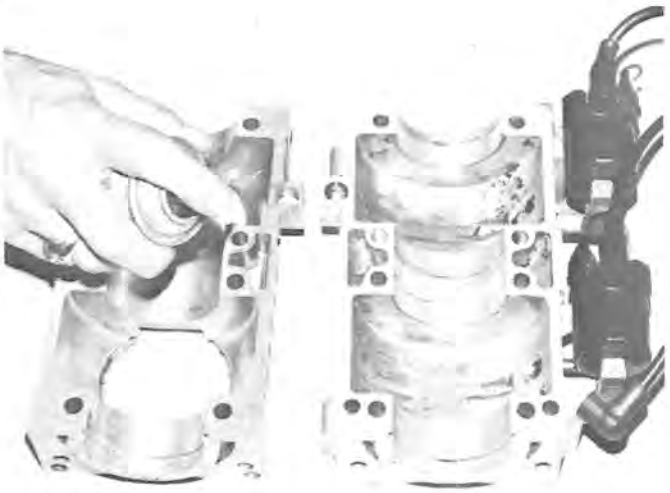


FIG. 1-29

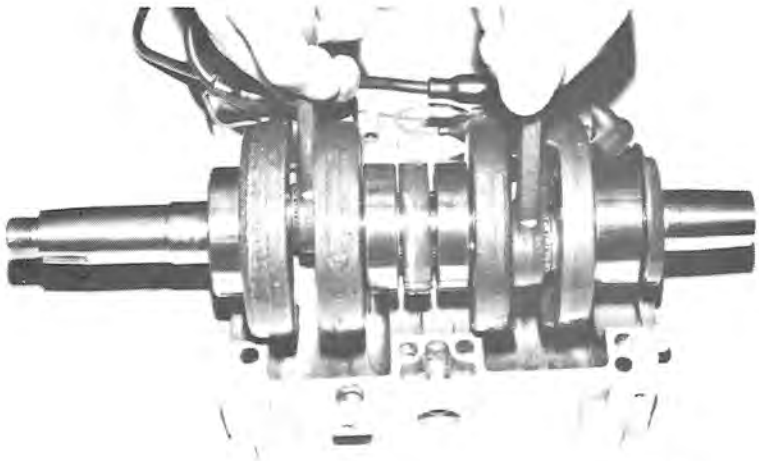


FIG. 1-30

Install two crankcase holding bolts in the center holes of the PTO side of crankcase. (Fig. 1-31) Tighten finger tight.

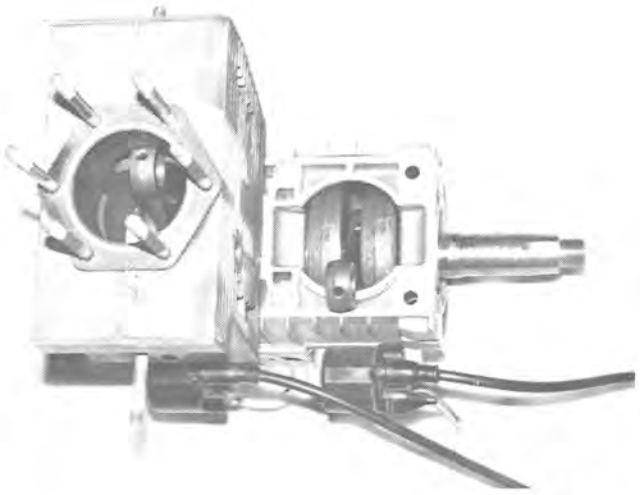


FIG. 1-31

C. Piston, Cylinder and Cylinder Heads

The pistons must be clean and free from carbon deposits and the piston rings must fit freely in their grooves. Rings are marked for proper side up. The arrow on the crown of pistons must point toward **exhaust side** of engine. Piston pins, needle bearings, check plates and circlips may now be installed, according to the procedure below. (Always use new circlips.) See Figs. 1-32, 1-33, 1-34, 1-35.)

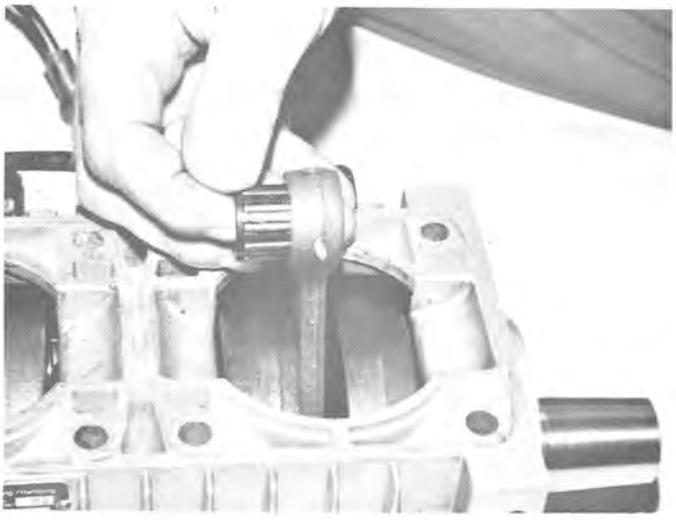


FIG. 1-32

FIG. 1-33

1. Oil the piston pin end bearings.
2. Install one circlip in piston.
3. Heat the piston sufficiently to allow pin to push into piston and install pin.
4. Install second circlip. (See Fig. 1-33 for correct orientation of circlips.)

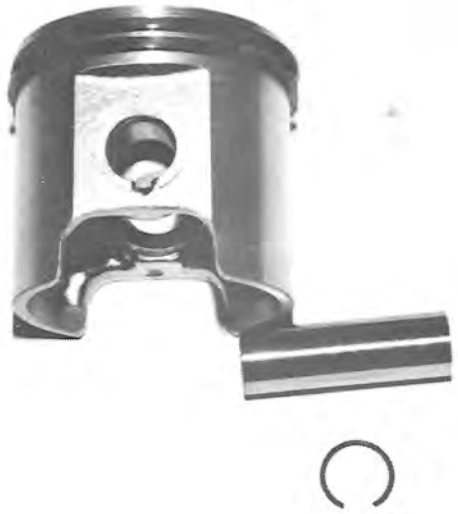


FIG. 1-34

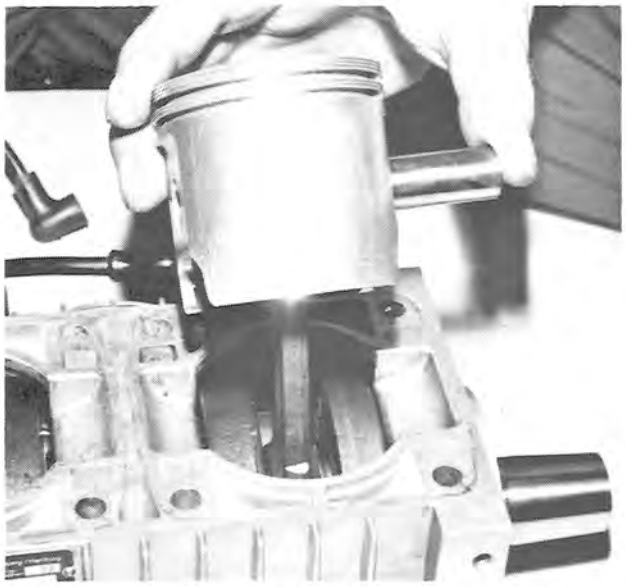


FIG. 1-35

Install base gaskets on the cylinder studs and position against the cylinder flanges (see Fig. 1-36). With the use of a ring compressor, lower cylinders one at a time over the pistons. Install base washers and nuts finger tight. See Fig. 1-37, 1-38.

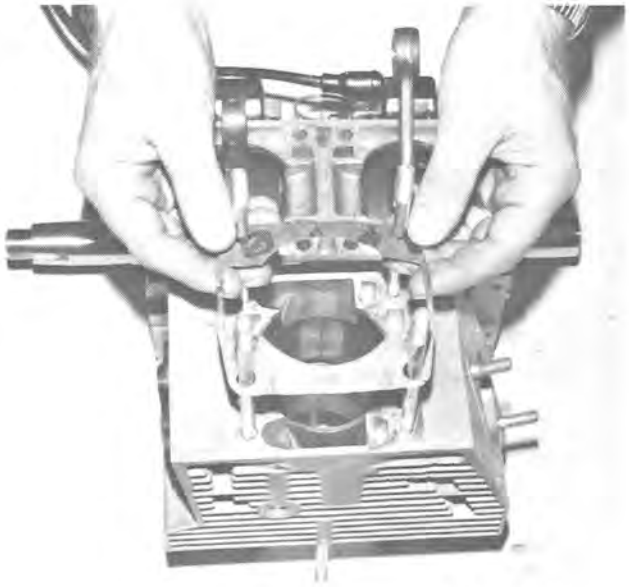


FIG. 1-36

Temporarily install the intake manifold without gaskets and tighten manifold nuts to sixteen (16) to eighteen (18) foot pounds. See Fig. 1-39. Cylinder base nuts may now be torqued to sixteen (16) to eighteen (18) foot pounds as outlined on specification page. The proper piston height can be measured at the top of the cylinder. The edge of the crown of the piston must not protrude above the top of the cylinder with the piston in the top dead center position. If the piston does protrude above the cylinder, a thicker base gasket must be used. See specification page for dimensions and color coding. It is important that only one cylinder at a time be adjusted or the crankcase will separate and lose it's seal.

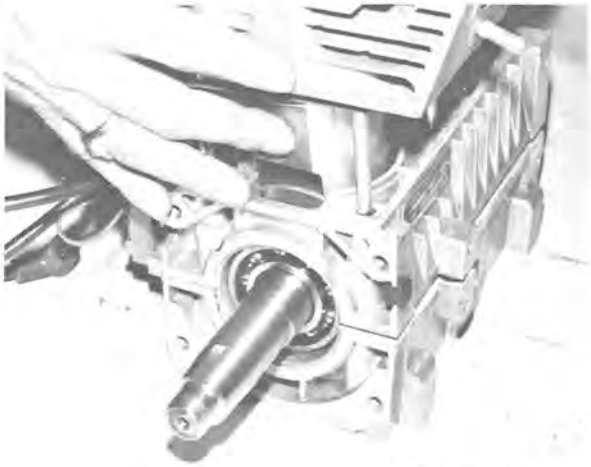


FIG. 1-37

FIG. 1-38

Oil cylinders and pistons before installing cylinder heads. Install head gaskets with the wide side of inner metal flange of the gaskets **up** toward the cylinder heads. Torque cylinder head nuts to sixteen (16) to eighteen (18) foot pounds. (See Fig. 1-40).

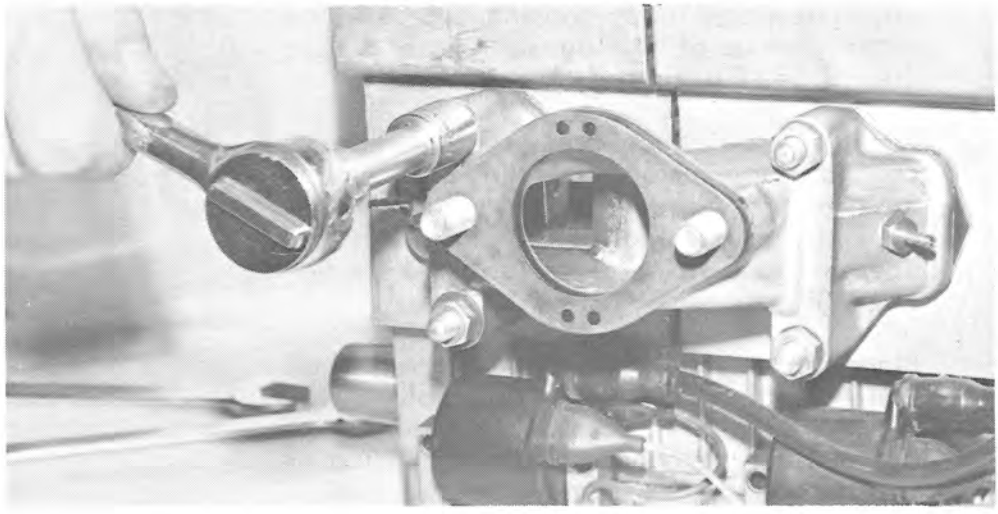


FIG. 1-39

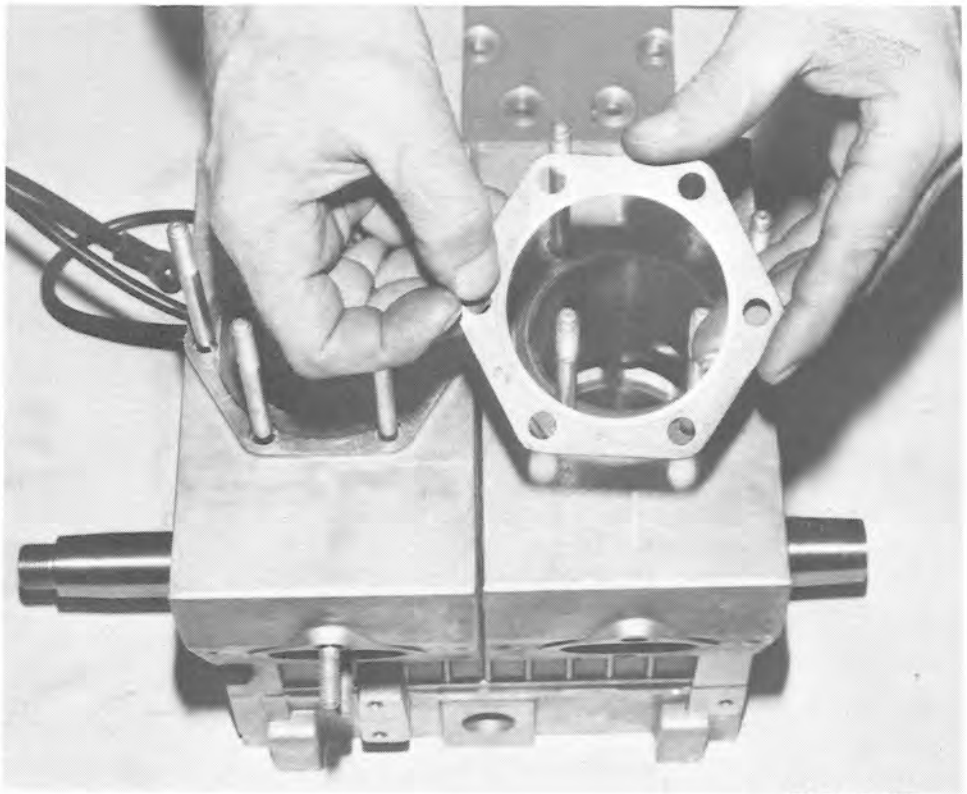


FIG. 1-40

D. Fan Housing and Impeller Bearings

Clean fan shaft hub. Install circlips and spacer. Use grease to hold spacer in place. Pack bearings in medium grease into housing with sealed surface outward. See Figs. 1-18, 1-19. Install fan and shaft.

E. Fan Housing and Armature Plate.

Install new seal in fan housing. Lubricate the inner groove of the oil seal with a light grease. See Fig. 1-38.

Install new o-ring and apply sealant material around o-ring surface (see Fig. 1-41). Install the armature plate wires through hole in fan housing and install armature plate with hold down screws, washers, and lockwashers. See Fig. 1-39.

Place fan housing assembly over crankshaft and position to crankcase assembly. Install the four Allen head screws and lockwashers and tighten evenly until fan housing is against crankcase assembly. See Fig. 1-40.

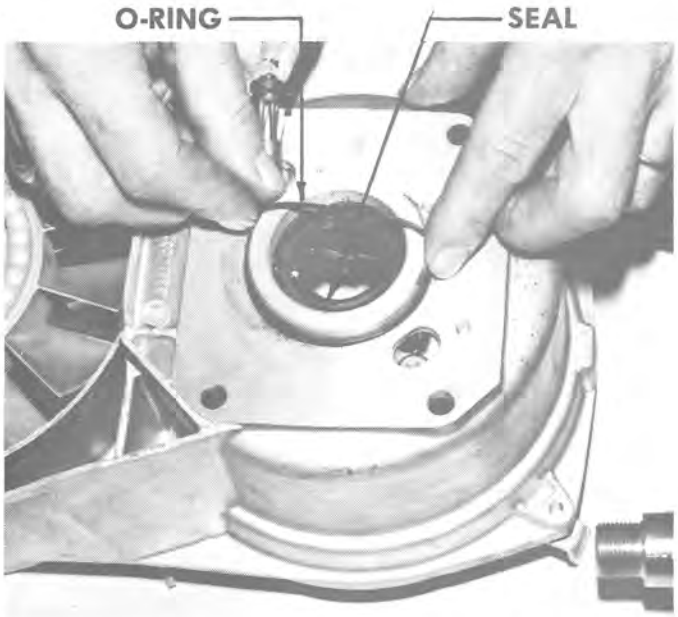


FIG. 1-38

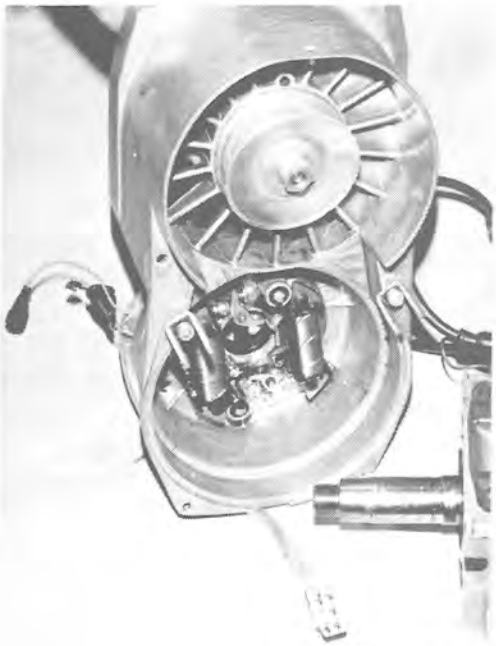


FIG. 1-39

FIG. 1-40

Torque to sixteen (16) to eighteen (18) foot pounds. Connect ignition wires to external ignition coil and to connector housing. Check ground wires for proper position. Install ignition cable bracket to fan housing.

F. Intake Manifold

Install spacers, gaskets and intake manifold (Fig. 1-44). Torque nuts evenly to sixteen (16) to (18) foot pounds.

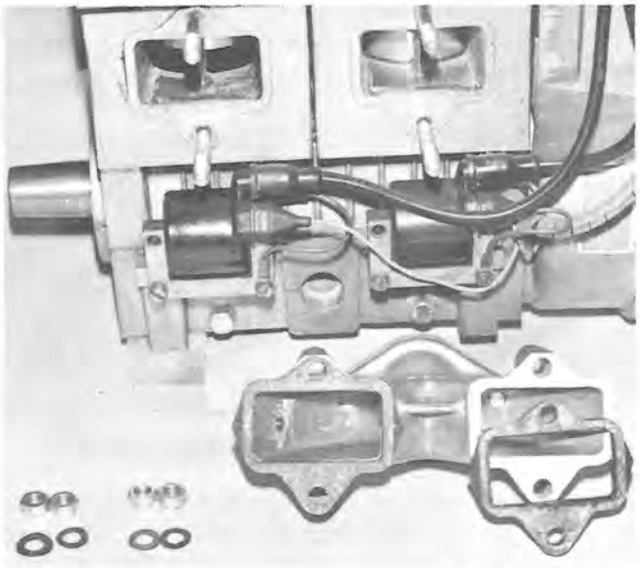


FIG. 1-44

G. Upper Fan Pulley Assembly

Install the tapered washer. Install pulley half, shims, second pulley half, tapered washer, lock washer and nut. Use 3/16" drill bit or punch to hold fan assembly and tighten nut. See Fig. 1-45.

H. Flywheel Assembly

Check advance mechanism for free operation, lubricate inside cam surface (Grooved area). Slide assembly over crankshaft and align key ways.

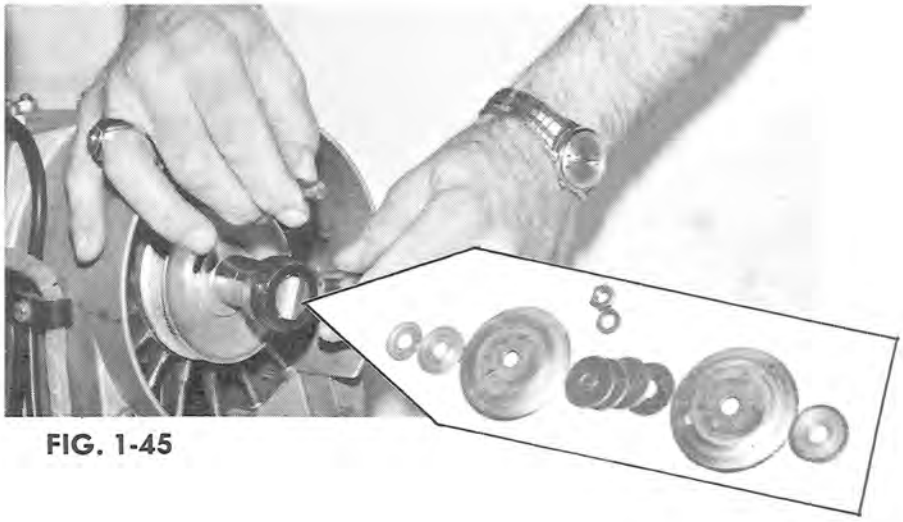


FIG. 1-45

Install key, lockwasher and nut in that order. Tighten securely. See Fig. 1-46. Follow Timing Procedure Section as next step.

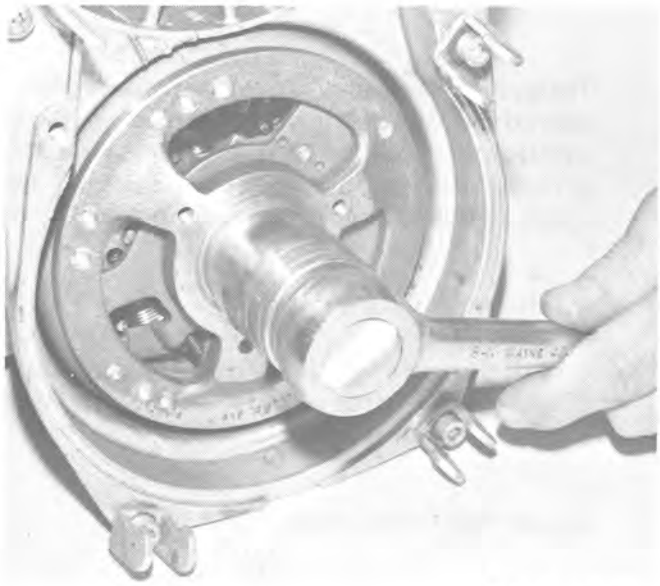


FIG. 1-46

I. Lower Fan Pulley Assembly

Install pulley half, belt, second pulley half, recoil carrier, lockwashers and bolts evenly while rotating crankshaft. The proper belt deflection should be 1/8" on each side. Proper adjustment can be made by adding or removing shims between upper pulley halves. See Fig. 1-47.

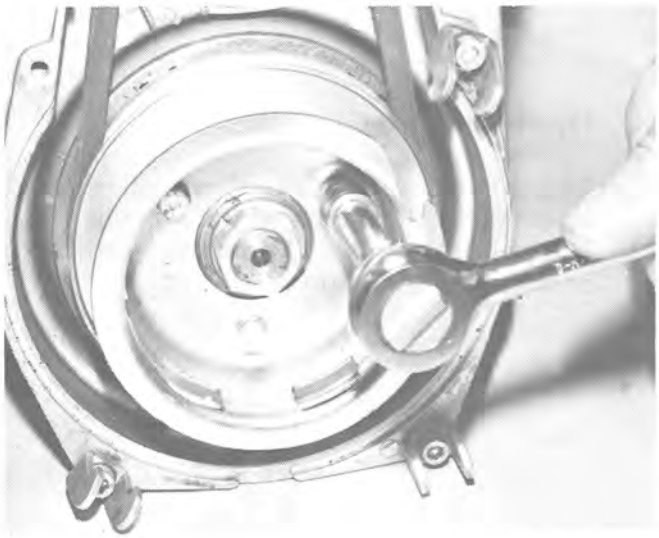


FIG. 1-47

J. Recoil Starter

Install the recoil starter assembly and tighten securely. See Fig. 1-48.

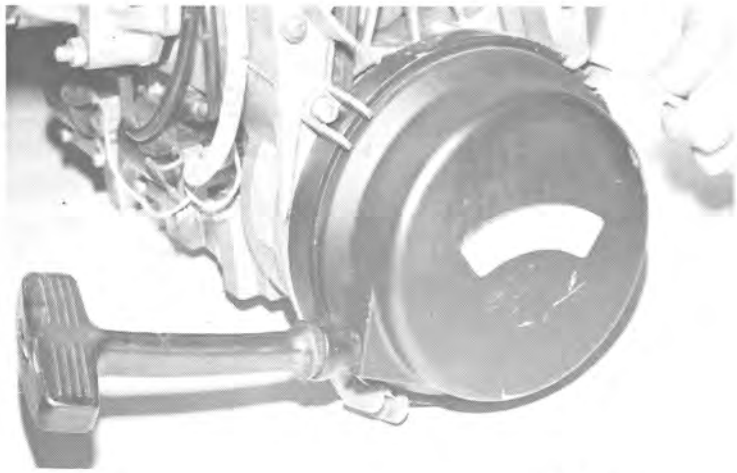


FIG. 1-48

RECOIL STARTER

Disassembly
(See Fig. 1-49 for recoil start breakdown, and Fig. 1-50 for Recoil Starter Assembly.)

1. Remove retaining nut (11), spring washer (12) and Thrust washer (8) from threaded shaft of reel hub. (Fig. 1-51).

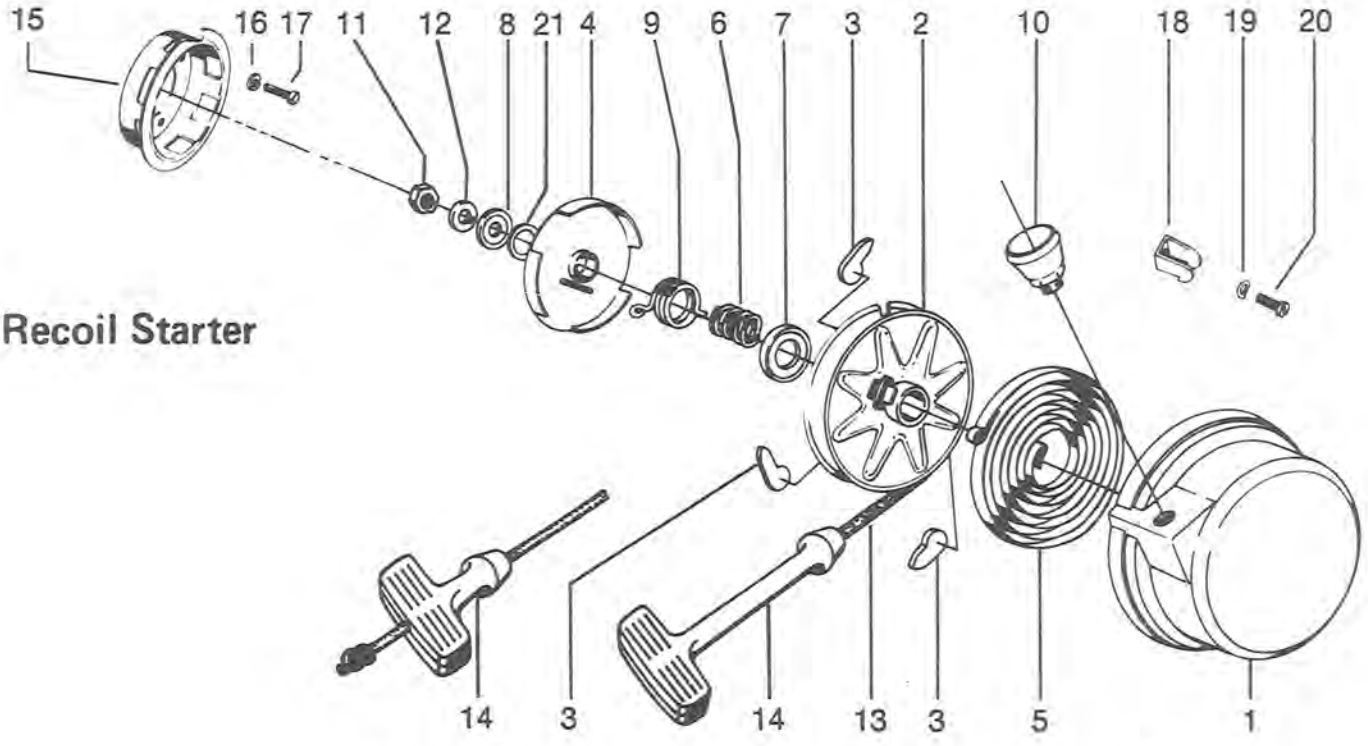
2. Manipulate friction plate (4) on reel hub until eye end of return spring (9) aligns with retaining slot. Remove friction plate. (Fig. 1-52, 1-53).

3. Remove the three pawls (3), (Fig. 1-54).

4. Remove return spring (9), spring (6) and cup washer (7). Fig. 1-53. Note position of plain end of return spring in the spring retaining hole in reel hub.

5. Unwind the rope; lift and untie the knotted end from center hub of reel, remove reel (2). (Fig. 1-55).

6. Lift long rolled end of main spring (5) from the fixed spring retaining pin in the case and carefully remove the spring (Fig. 1-56).



Recoil Starter

FIG. 1-49

7. Clean all parts, except rope, using a suitable cleaning solvent. If rope requires cleaning, wash it in a solution of soap and water. Thoroughly dry all parts after cleaning.

8. Inspect all parts for obvious damage and wear.

FIG. 1-50

FIG. 1-51

FIG. 1-52

FIG. 1-53

FIG. 1-54

FIG. 1-55

FIG. 1-56

Assembly

1. Replace defective parts.
2. Install main spring as follows:
   a. Secure main spring winding tool, part number 43-0797-60, or equivalent tool, circular end up, in a suitable bench vise.
   b. Start with the long rolled end of main spring (5) and wind spring into circular end of tool in a clockwise direction. (Fig. 1-57).
   c. Remove tool from vise. Grasp the tool by its handle and lower the tool, with spring installed, into case (1) (Fig. 1-58).
   d. Secure the long rolled end of spring over the fixed spring retaining pin. (Fig. 1-59). Remove winding tool (Fig. 1-60). Apply a light film of Lubriplate, or equivalent, to spring.
3. Secure case, open side up, in bench vise.
4. Tie a knot at one end of the rope. Secure knotted end in the center of reel (2). Pull rope taut and wind entire rope around reel in an anti-clockwise direction until the free end protrudes through the notched section of the reel.
5. Apply a light film of Lubriplate, or equivalent, to center hub of case and install the reel. Push down and rotate reel in an anti-clockwise direction until the hook engages with the free end of main spring. Tension will be felt when reel and spring are properly engaged. (Fig. 1-61, 1-62).
6. Rotate reel a maximum of three complete turns in an anti-clockwise direction. Do not exceed three turns; hold reel in this position and feed free end of rope through case at the rope guide hole. Install rope guide. Loosely knot the rope to prevent recoil.
7. Apply a light film of Lubriplate or equivalent to pawls (6) and install them on the reel in the pawl retainers. (Fig. 1-63). (See Fig. 1-49 for part identification numbers.)
8. Install cup washer (7) flat side down, spring (6) and return spring. Ensure that plain end of return spring is properly engaged in the retaining hole in reel hub.

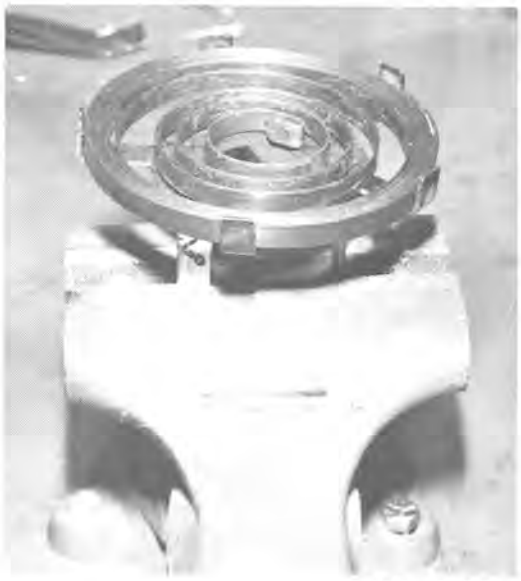


FIG. 1-57

FIG. 1-58

FIG. 1-59

9. Install friction plate (5) over reel hub. Manipulate plate until eye end of return spring engages and locks crosswise in retaining slot.

10. Rotate friction plate until the three notches are aligned with pawls when pawls are at the recoil position.

11. Install flatwasher (8), lockwasher (12) and nut (11). Tighten nut securely.

12. Untie the temporary knot in free end of rope and install the rope handle. Tie a permanent knot and fit handle securely.

13. Check starter for proper operation. When handle is pulled outward, pawls should move outward.

NOTE:

If main spring is to be installed without the use of a spring winding tool, wind main spring into case in an anti-clockwise direction. Clockwise installation on the winding tool is necessary to ensure correct anti-clockwise installation of the spring when tool is placed upside down in the case.

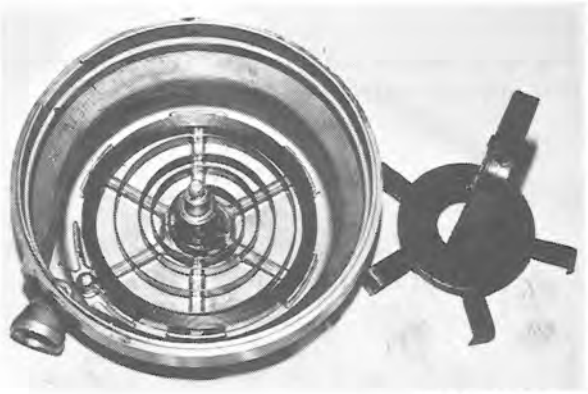


FIG. 1-60

FIG. 1-61

FIG. 1-62

FIG. 1-63

TIMING PROCEDURE

NOTE: Recoil starter, carrier, lower pulley assembly and spark plugs should be removed before beginning timing procedure.

A. Install the dial indicator assembly into spark plug hole of No. 1 cylinder (P.T.O. side). See Fig. 1-64.

B. Attach negative lead of ohmmeter to engine ground. Attach positive lead of ohmmeter to No. 1 cylinder terminal in connector housing. See Fig. 1-65.

C. Rotate flywheel counterclockwise until points are on the high side of cam on No. 1 cylinder. Points are at maximum open position observed through opening in flywheel. Check gap with wire gauge and adjust to .015 if necessary. See Fig. 1-66.

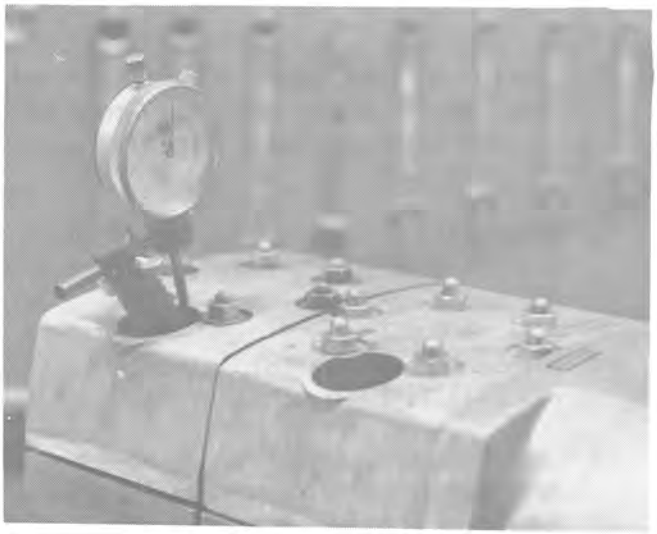


FIG. 1-64

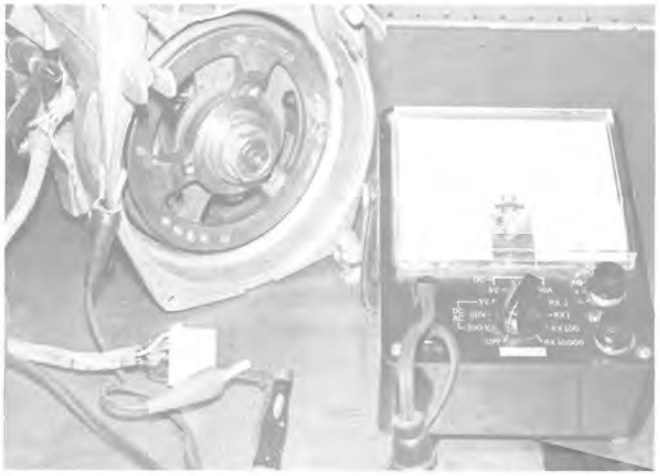


FIG. 1-65

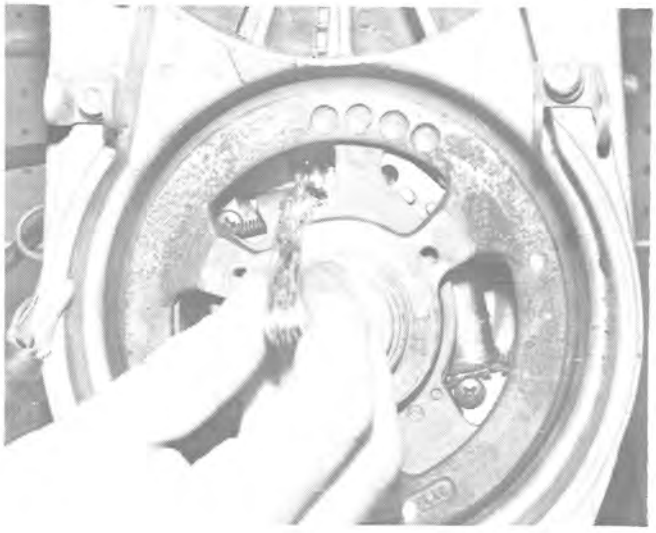


FIG. 1-66

D. Rotate flywheel counterclockwise to top dead center and adjust dial to zero. Place selector knob on ohmmeter to R x 1. Ohmmeter needle will indicate a closed circuit. See Fig. 1-67.

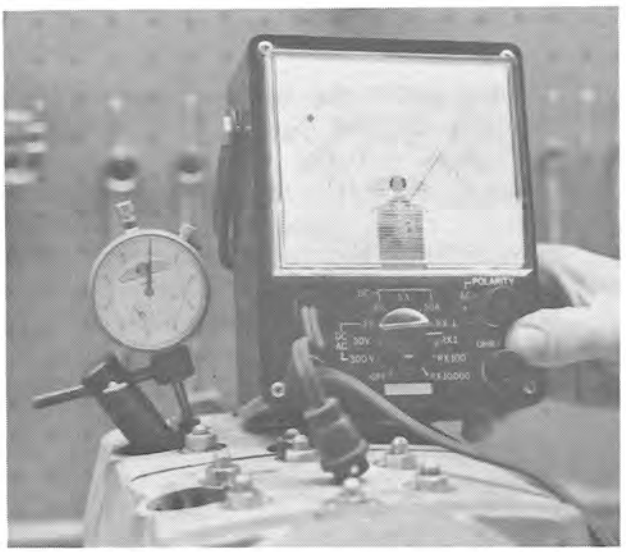


FIG. 1-67

Move the centrifugal weights in flywheel to the **full** advanced position. See Fig. 1-68.

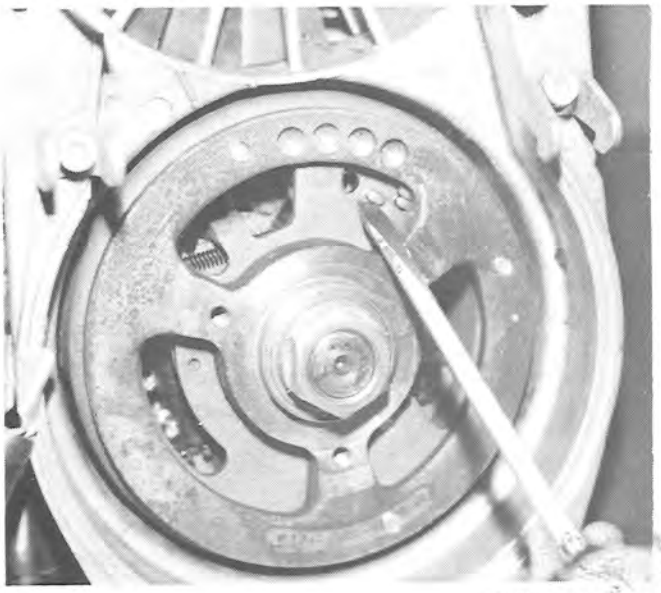


FIG. 1-68

Rotate flywheel counterclockwise one complete revolution to between .102 and .112. See Fig. 1-69.

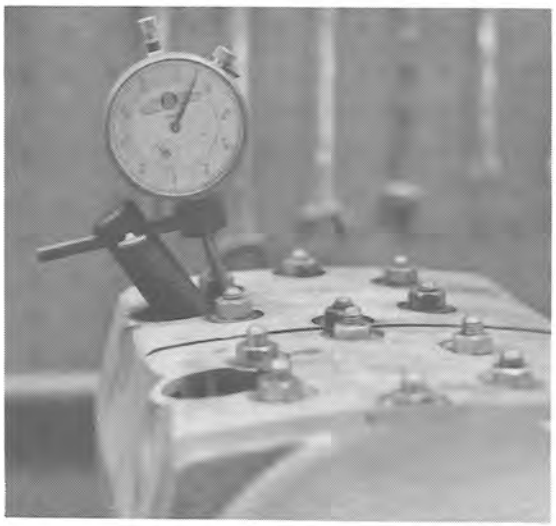


FIG. 1-69

At this point the breaker points for No. 1 cylinder should open. (Break contact) This will show on the ohmmeter. Needle will move to the left. If this does not occur, the armature plate needs adjusting. This is accomplished by loosening the hold-down screws and turning plate either left or right while observing needle action. With proper positioning, needle should move to left with slight movement of armature plate and flicker back with opposite plate movement. Tighten hold-down screws **securely.** Re-check procedure. See Fig. 1-70.

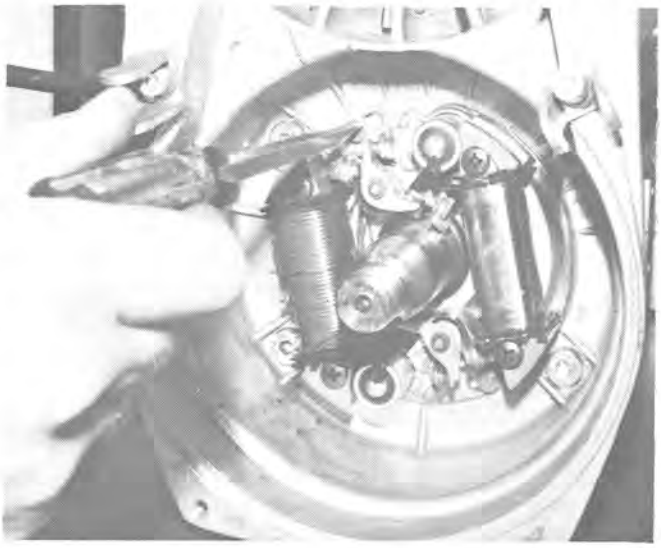


FIG. 1-70

NOTE:
In Fig. 1-70 flywheel has been removed for clarity of illustration.

E. Remove dial indicator assembly and install in No. 2 cylinder (fan side). See Fig. 1-71.

Attach positive lead of ohmmeter to No. 2 cylinder terminal in connector housing.

Rotate flywheel counterclockwise to top dead center. Set dial indicator to zero. Again move centrifugal weights in flywheel to full advanced position. Rotate flywheel counterclockwise while watching dial indicator. The needle must make one full revolution and stop at between .102 and .112. At this point, needle should move to left indicating point contact open. If this does not occur, points need slight adjustment. Re-check procedure.

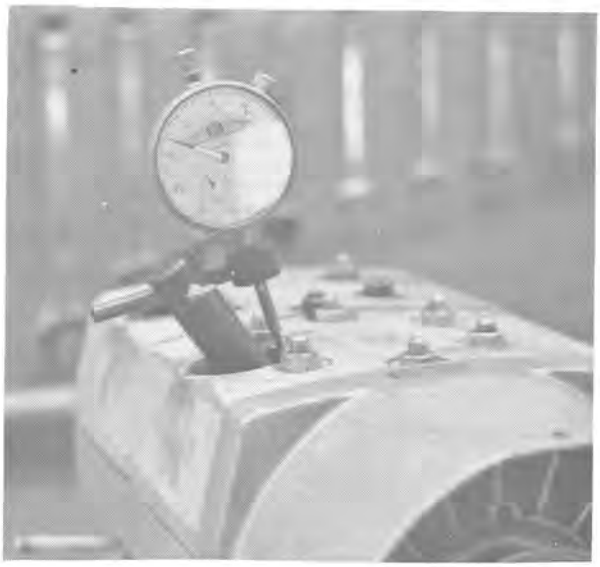


FIG. 1-71

TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
Manual starter rope comes out but pawls don't engage.	1. Lack of friction plate return spring action. 2. Defective pawls.	1. Check friction plate return-spring. Replace as required. 2. Check for broken or bent pawls. Replace pawls as required.
Manual starter rope doesn't return.	1. Recoil spring broken or bent. 2. Pulley housing warped or bent. 3. Starting pulley worn.	1. Replace spring. 2. Replace housing. 3. Replace pulley.
Hard to start or won't start.	1. Inoperative diaphragm or inlet check valve. 2. Fuel enrichening valve not not pulled up to start. 3. Spark plugs improperly gapped, dirty or broken. 4. Magneto breaker points improperly gapped or dirty. 5. Head gasket blown or leaking. 6. Empty gas tank or improper fuel mixture. 7. Water in fuel system. 8. Weak coil or condenser. 9. Obstructed fuel system.	1. Refer to Carburetor Section. 2. Ensure enrichening valve is pulled up. 3. Remove plugs. Clean, adjust or install new plugs. 4. Clean, adjust or replace points. 5. Replace gasket. 6. Refill tank with specified fuel/oil mixture. 7. Drain fuel from carburetor. Add carburetor de-icer as required to fuel. 8. Replace faulty coil or condenser. 9. Disconnect fuel lines. - Clear obstruction. Flush system. Connect fuel lines.

TROUBLE SHOOTING CHART (CONT.)

TROUBLE	PROBABLE CAUSE	REMEDY
	10. Air leak in crankcase or inlet system.	10. Check crankcase pressure (3-6 PSIG)
	11. Primary wire broken.	11. Repair or replace primary wire.
	12. Engine not timed properly.	12. Re-time engine.
	13. Secondary wire not connected or spark plug protector not installed properly.	13. Secure secondary wire or spark plug protector.
Impossible to adjust idle.	1. Spark retarding mechanism not working properly.	1. Repair retard mechanism.
	2. Pistons or rings worn.	2. Replace as necessary.
	3. Faulty carburetor.	3. Check carburetor, check valve. Refer to Carburetor Section.
Missing at low speed or won't idle smoothly or slowly.	1. Incorrect carburetor idle adjustment.	1. Adjust idle-Refer to Carburetor Section.
	2. Spark plugs improperly gapped or dirty.	2. Clean, adjust or install new plugs.
	3. Head gasket blown or leaking.	3. Replace gasket.
	4. Loose or broken magneto wires.	4. Repair or replace wires.
	5. Magneto breaker points improperly gapped or dirty.	5. Adjust, clean or install new points.
	6. Weak coil or condenser.	6. Replace coil or condenser.
	7. Improper fuel mixture. (1) Too much oil (2) Too little oil	7. Refuel, using specified fuel/oil mixture.
	8. Leaking crankshaft seal.	8. Replace seal.
Missing at high speed or intermittent spark.	1. Spark plugs improperly gapped or dirty.	1. Clean, adjust or install new plugs.
	2. Loose or broken magneto wires.	2. Repair or replace wires.
	3. Magneto breaker points improperly gapped or dirty.	3. Clean, adjust or install new points.
	4. Weak coil or condenser.	4. Replace coil or condenser.
	5. Heat range of spark plug incorrect.	5. Install specified spark plugs.
	6. Leaking head gasket.	6. Replace head gasket.
	7. Engine improperly timed.	7. Re-time engine.

TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
Coughs, spits, slows down, surges	1. Idle or high speed jets too lean. 2. Leaking gasket flange. 3. Inlet control level set too low. 4. Pulsation line obstructed. 5. Fuel pump not supplying enough fuel due to: (1) Punctured diaphragm. (2) Inoperative inlet check valve.	1. to 5. Adjust carburetor. Refer to Carburetor Section.
	6. Crankcase not properly sealed.	6. Reseal crankcase.
	7. Idle or main carburetor nozzle obstructed.	7. Refer to Carburetor Section.
	8. Fuel line obstructed.	8. Remove fuel line. Clear obstruction. Replace line.
	9. Carburetor inlet needle and seat obstructed.	9. Refer to Carburetor Section.
Overheating	1. Carburetor too lean.	1. and 2. Adjust carburetor. Refer to Carburetor Section.
	2. Carburetor too rich.	
	3. Incorrect timing.	3. Retime engine to Specifications.
	4. Too much carbon.	4. Remove cylinder heads. Clean top of pistons and inside compression chamber. Clean out exhaust port.
	5. Spark plug too hot.	5. Install specified spark plugs.
	6. Engine fan belt loose or broken.	6. Replace or adjust.
	7. Air leak in manifold.	7. Tighten nuts or change gaskets.
	8. Crankcase seal leaking.	8. Fit new seal.
Vibrates excessively or runs rough and smokes.	1. Idle needle or high speed carburetor jet too rich.	1 to 4. Adjust needle or change jet. Refer to Carburetor Section.
	2. Enrichening valve not operating properly (bent linkage).	
	3. Float lever too high. (carburetor floods).	
	4. Air bleed plugged.	
	5. Muffler obstructed.	5. Check and clear muffler.
	6. Engine not secured tightly to engine support.	6. Tighten engine mounting bolts.
	7. Water in gas.	7. Add carburetor de-ice fluid as required.

TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
Won't start, kicks back and backfires.	1. Spark plug wires reversed. 2. Flywheel key missing or sheared. 3. Faulty condenser. 4. Improper timing. 5. Faulty breaker points. 6. Unhooked spark retarding mechanism - or spring broken.	1. Install wire correctly. 2. Replace key. 3. Replace condenser. 4. Re-time engine. 5. Adjust or replace points. 6. Reconnect mechanism or replace spring.
No acceleration, low top R.P.M., hard to start.	1. Spark plugs improperly gapped or dirty. 2. Magneto breaker points improperly gapped or dirty. 3. Faulty coil or condenser. 4. Loose or broken magneto wires. 5. Blown head gasket. 6. Float lever adjustment too high. 7. Crankcase leaking. 8. Main (high speed) jet too rich.	1. Clean, adjust or install new plugs. 2. Clean, adjust or install new points. 3. Replace coil or condenser. 4. Repair or replace magneto wires. 5. Replace head gasket. 6. Refer to Carburetor Section. 7. Install new seal. 8. Change jet.
Good spark but engine runs on one cylinder.	1. Leaking cylinder head. 2. Magneto wires broken inside (coil ground broken). 3. Cracked cylinder wall. 4. Defective spark plug. 5. Breaker points improperly gapped. 6. Crankcase seal leaking.	1. Check head for warps, cracks. Install new gasket and cylinder head. 2. Repair or replace wires. 3. Replace faulty cylinder. 4. Clean, adjust or install new plug. 5. Re-adjust points. 6. Install new seal.
No acceleration. Idles well but dies down when put to full throttle.	1. Low speed needle set too lean. 2. Dirt behind needle and seat. 3. High speed jet obstructed. 4. Float lever set too low. 5. Silencer obstructed. 6. Fuel pump not supplying enough fuel due to: (1) Punctured diaphragm (2) Non-functioning check valves. 7. Fuel line obstructed. 8. Not enough oil in gas. 9. Breaker points improperly gapped or dirty. 10. Engine improperly timed.	1. to 6. Adjust carburetor. Refer to Carburetor Section. 7. Remove fuel line. Clear obstruction. Replace line. 8. Refuel, using specified fuel/oil mixture. 9. Adjust, clean or install new points. 10. Re-time engine to specifications.

TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
No power under heavy load.	1. Magneto breaker points improperly gapped or dirty. 2. Ignition timing too far advanced. 3. Magneto coil plate loose.	1. Clean, adjust or install new points. 2. Adjust timing. 3. Check magneto and secure coil plate.
Cranks over extremely easy on one or both cylinders. Loss of compression.	1. Scored piston. 2. Blown head gasket. 3. Loose spark plug. 4. Head bolts not tight.	1. Replace faulty piston. 2. Replace head gasket. 3. Check plug for security. 4. Torque head bolts to proper specifications.
Engine won't crank over. Unable to rotate flywheel.	1. Piston rusted to cylinder wall. 2. Crankshaft seized to bearing. (main or rod) 3. Broken connecting rod. 4. Flywheel seized to coil plate. 5. Engine improperly assembled after repair.	1. Remove piston and cylinder. Replace defective parts. 2. & 3. Disassemble engine. Replace defective parts. 4. Remove flywheel. Replace defective parts. 5. Recheck re-assembly procedure.

1976
Scorpion
Range Whip

Service Manual

Carburetor
Section

Functional Description:

General:

The purposes of the carburetor are (1) to provide the amount of fuel that the engine needs in operation and (2) to properly mix the fuel with air so that it will vaporize.

Pulsations, from the engine crankcase through the impulse line, actuate the carburetor fuel pump to move the fuel from the fuel tank into the carburetor. The fuel level in the carburetor fuel reservoir is maintained by a float-controlled needle valve that opens as the level drops and closes as the fuel rises to a specific level. The engine fuel demand determines the air flow through the carburetor throttle bore. The air flow rate varies the pressure differential on the fuel in the reservoir. This pressure differential forces fuel into the throttle bore through one or more openings depending upon the operational phase of the engine.

The function of each element of the carburetor is described below. (See Fig. 2-1).

1. **Engine Impulse:** Actuates fuel pump diaphragm with alternating pressure-vacuum pulses from engine revolutions.
2. **Fuel Pump Diaphragm:** Fluctuates in response to engine impulse. Draws fuel into surge chamber with upward, vacuum stroke, of engine piston. Pushes fuel with pressure downward stroke of engine piston, through outlet check valve.
3. **Fuel Inlet Fitting:** Fuel drawn through line from tank.
4. **Fuel Channel:** Fuel is routed into surge chamber.
5. **Surge Chamber:** Fuel accumulates waiting for inlet check valve to open for passage at engine piston down stroke.
6. **Surge Diaphragm:** Reciprocates with pump diaphragm balancing to atmospheric pressure, cushions pulsations.
7. **Leaf Spring:** Assists pump diaphragm when engine impulses are weak at starting and idle circuits.
8. **Inlet Check Valve:** When opened by engine vacuum, allows fuel passage from surge chamber into pump chamber, feeding to outlet check valve.
9. **Outlet Check Valve:** Opened by engine pressure pulse forcing fuel down through inlet valve needle passage.
10. **Fuel Channel:** Routes fuel to inlet needle valve.
11. **Filter Screen:** Fuel is filtered before fed into inlet needle valve. Cleanse screen when servicing by flushing or air stream.
12. **Inlet Valve Seat:** Hole through which fuel feeds when needle valve drops slightly away.
13. **Inlet Needle Valve:** As float rises it pushes valve into seat closing off fuel passage. When float drops, needle opens hole in seat allowing fuel to flow into bowl reservoir.
14. **Lever:** Raises and lowers with float to activate inlet needle valve.
15. **Float:** Raises and lowers to maintain fuel level as fuel is used.
16. **Fuel Bowl Reservoir:** Constant level of fuel stored and maintained by float action on lever to open and close inlet needle valve.

The four operational phases of the Walbro Float Carburetor used on the 1976 Range Whip are:

(1) Starting operation
(2) Idle operation
(3) Part-throttle operation
(4) Full-throttle operation

Detailed performance of the carburetor in each of the four phases is described below. Figures 2-1 through 2-4 are schematic diagrams and as such are accurate, functional representations of the carburetor, but in some features deviate from actual physical appearance.

Starting Circuit

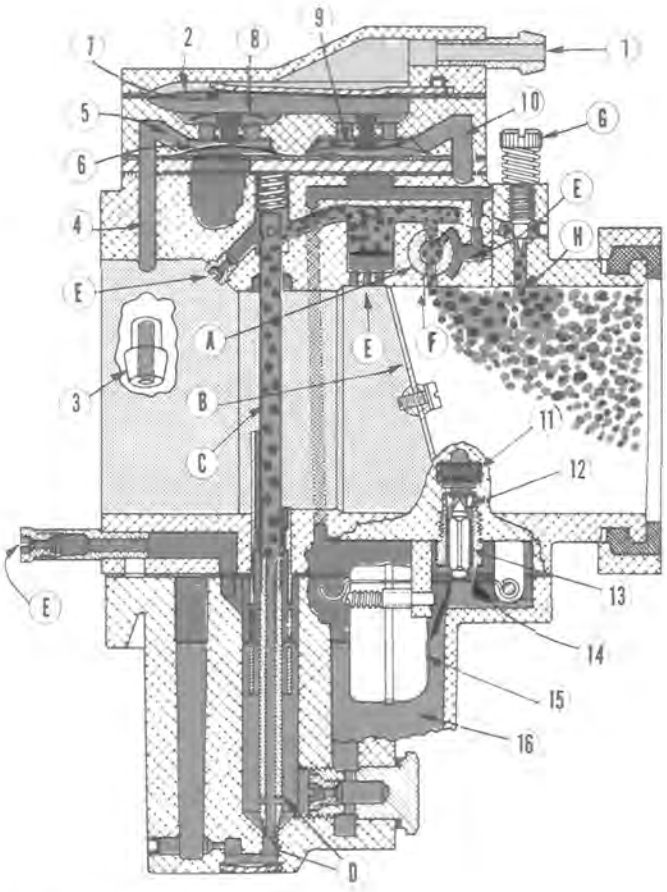


FIG. 2-1

A. **Enrichment Valve:** : In operation when control lever, is up (vertical), elimates choke. Like opening a faucet an extra column of fuel is introduced through the valve into carburetor bore as engine is cranked; offering easier, quicker starts. This valve may be left open until engine is warm.

B. **Throttle Valve:** Must be at idle position freeing both hands for starting. Required air is drawn in through the air bleed ports mixing with the fuel.

C. **Start & Idle Fuel Feed Tube:** Fuel is drawn by engine vacuum up tube, through part throttle passage into Enrichment Valve and idle circuit.

D. **Enrichener & Idle Feed Ports:** Tube picks up at these two pockets for starting full volume.

E. **Air Bleeds:** Vacuum draws in air at these four points to mix with fuel in metered ratio.

F. **Enrichener Port:** Fuel and air mixture flows into throttle bore when enrichener valve is open.

G. **Idle Needle:** Fuel is also drawn through the idle needle circuit which is pre-set for the idle position.

H. **Idle Feed Hole:** Additional fuel is discharged from this port into throttle bore for starting.

COLOR CODE — Fuel — Air — Crankcase Impulse Air

Idle Speed Circuit

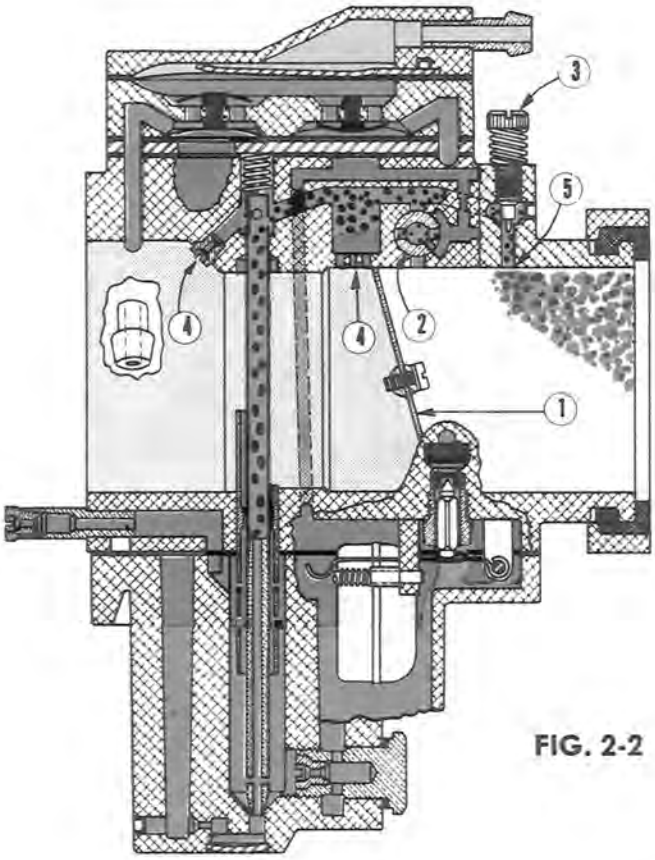


FIG. 2-2

1. **Throttle Valve:** Remains closed, air being drawn through Idle Air Vent.

2. **Enrichment Valve:** Closed as engine warms.

3. **Fuel Idle Needle:** As engine requires, needle is turned **in** to **lean** mixture or turned **out** to allow greater fuel flow (like a water faucet). During break-in, open 1½ turns then close about ½ turn after break-in.

4. **Idle Air Vent:** Engine vacuum draws air through this interchangeable fixed jet as well as through the part throttle progression holes.

5. **Fuel Idle Passage:** All fuel for idling is drawn through this passage. The flow can be adjusted by the Fuel Idle Needle.

Part Throttle Circuit

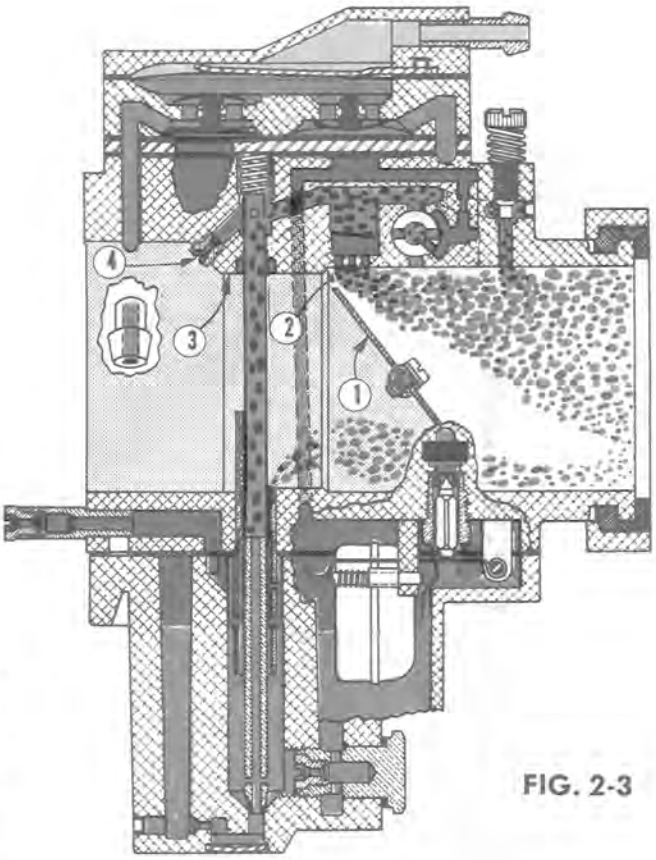


FIG. 2-3

1. **Throttle Valve:** Fuel is being fed through idle circuit. As the Throttle Valve is opened a series of three holes is exposed progressively offering smooth acceleration as they increase fuel flow.

2. **Part Throttle Holes:** Three holes are skillfully located and carefully sized to feed measured fuel drawn by vacuum as each hole is allowed to flow with opening of the Throttle Valve.

3. **Venturi:** This acts as a restriction to the air rushing through the carburetor bore into the engine to fill the vacuum left by the piston movement. As the air velocity increases at the venturi the pressure is dropped according to the degree Throttle Valve is opened. As the Part Throttle holes are exposed to the drop in pressure, fuel rushes in to help bring the air pressure up. The Idle Feed hole continues to flow for the same reason.

4. **Air is also fed by the Idle Air Vent Jet,** affecting the vacuum which lifts fuel up the feed tube. A smaller jet delivers less air, and therefore a richer mixture, especially at "early" part throttle.

High Speed Circuit

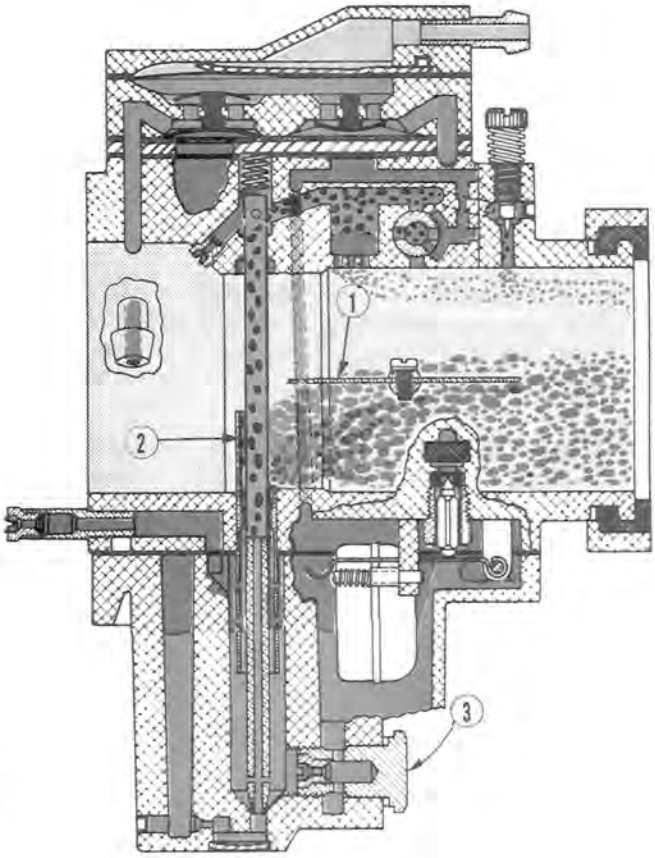


FIG. 2-4

1. **Throttle Valve:** Valve is wide open to allow full air and fuel flow, metered to control top engine speed.

2. **Main Fuel Nozzle:** As the throttle opens, air velocity increases through the venturi and the resultant vacuum draws fuel from the main nozzle.

3. **High Speed Fixed Jet:** Fuel is fed to the fixed jet hole from the bowl reservoir. The hole may be varied in size by exchanging the jet on which sizes are stamped. Larger engines require larger jet holes for greater fuel consumption. Too large creates a rich mixture, too small a **dangerous** lean mixture.

   Note: High altitudes require a smaller jet to compensate for the thinner air.

Note: **Air Intake Silencer:** Regulations require the noise created by air rushing into the carburetor be reduced to a minimum. All WF models are finely calibrated in tune with original equipment Silencers, both Intake and Exhaust. Anytime the characteristics of either are changed or removed a risk of burning out an engine exists and Warranty is void.

Carburetor Disassembly

Fuel Pump and Gaskets

1. Remove four (4) mounting screws. (See FIG. 2-5).
2. Lay out parts in sequence shown in FIG. 2-6. Do not remove rubber fuel pump valves unless replacements are available.
3. Inspect all parts, openings, needles, valves, valve seats and any other functioning part for clogging or damage. (See Fig. 2-7).
4. Clean parts with a mild solvent or regular fuel mixture. Repair or replace parts as necessary.

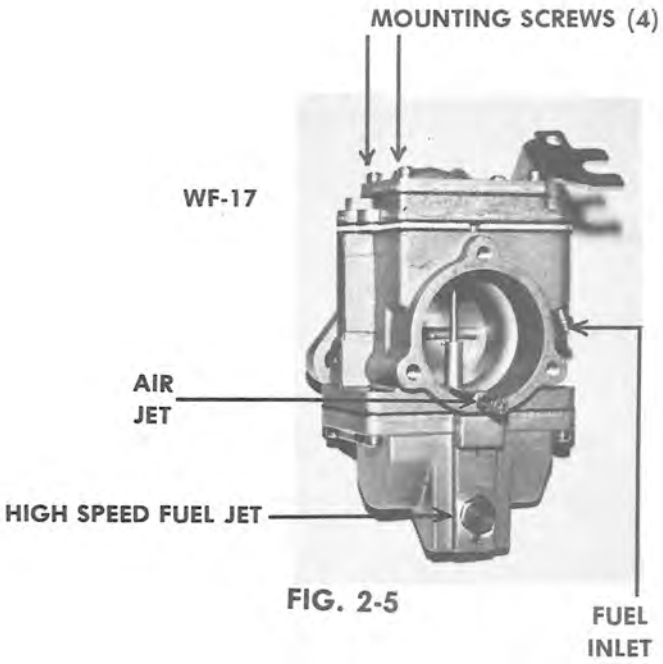


FIG. 2-5

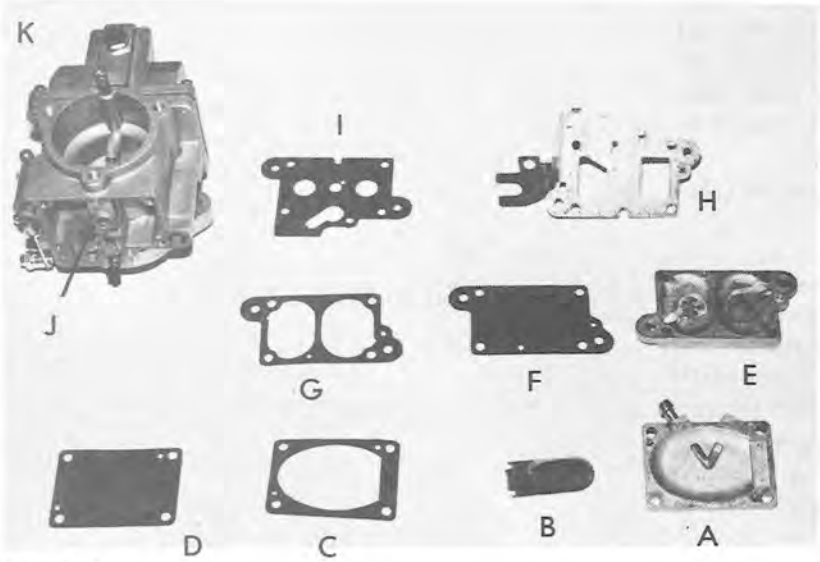


FIG. 2-6

A. Fuel pump cover assembly
B. Fuel pump leaf spring
C. Pump gasket
D. Pump diaphragm
E. Fuel pump body assembly
F. Surge chamber diaphragm
G. Surge chamber gasket
H. Throttle bracket plate
I. Fuel pump to body gasket
J. Idle Fuel feed tube (Also see FIG. 2-13)
K. Carburetor body assembly with float bowl assembly

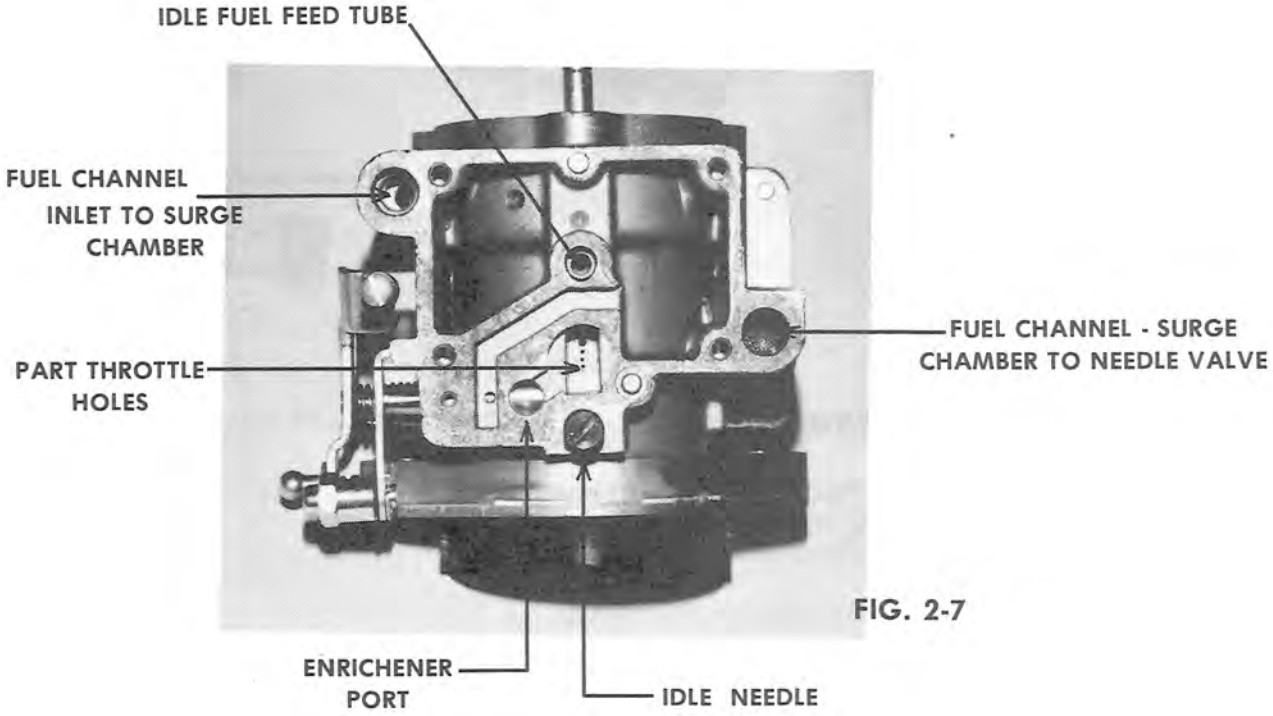


FIG. 2-7

Fuel Bowl and Gasket

1. Remove four (4) mounting screws. (See FIG. 2-8)
2. Lay out parts sequentially as shown in FIG. 2-9.
3. Check all parts openings, valves, valve seats and other functioning parts for clogging or damage. Clean, repair and replace as necessary.
4. Clean parts with a mild solvent or regular fuel mixture. Clean all sediment from the bottom of the bowl. Remove the main jet and idle feed tube. Blow air through the idle feed circuitry and main air bleed circuit.

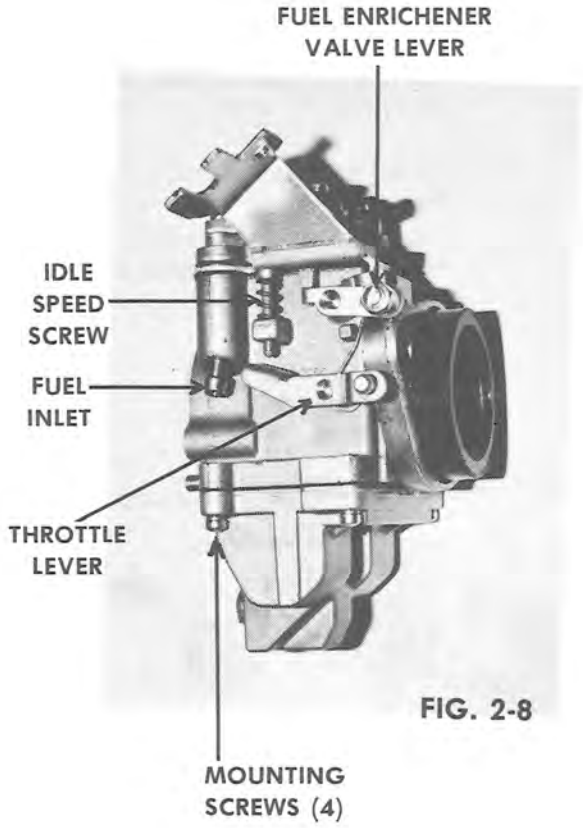


FIG. 2-8

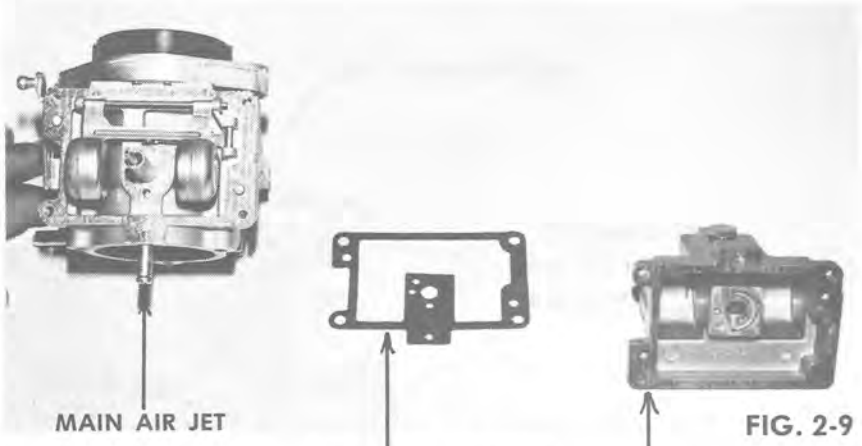


FIG. 2-9

Carburetor Reassembly

1. Reassemble in reverse process of disassembly. Install components on top of the carburetor first followed by the float bowl assembly.

2. Specific care should be exercised in the following areas:

   a. The fuel pump leaf spring should be flat to center between the two castings when seated.

   b. Carefully position the idle feed tube and tube pressure spring.

   c. During installation, wind the float support spring ½ turn from rest position for correct loading. (See FIG. 2-10)

   d. Slide the fuel bowl gently over the point of the idle feed tube. A slight tension against the tube pressure spring should be felt just before the bowl seats on its gasket.

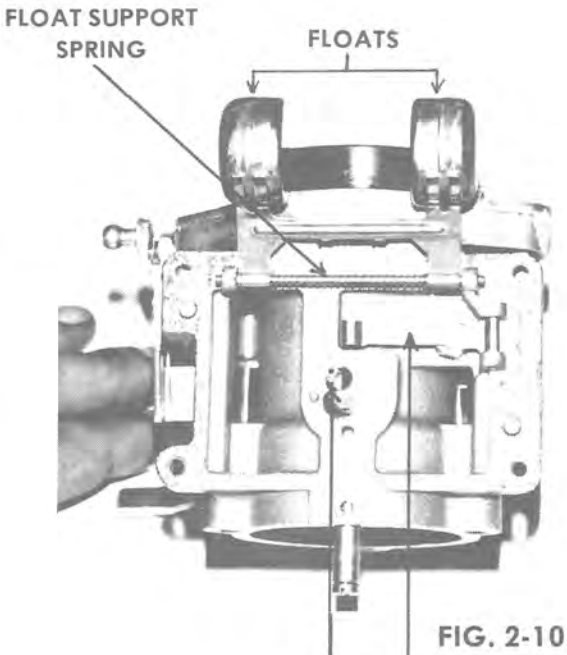


FIG. 2-10

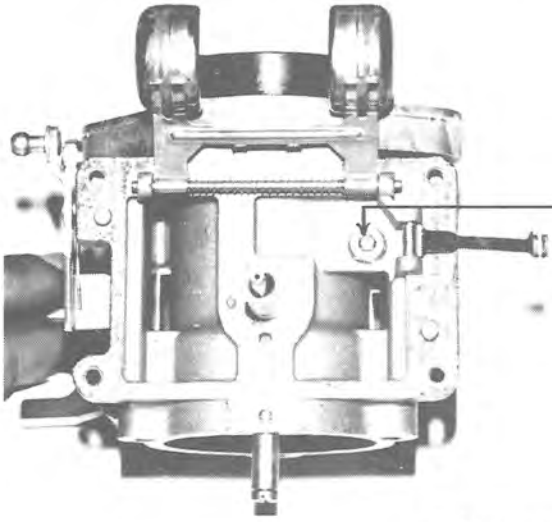


FIG. 2-11

Adjustments

1. **IDLE FUEL** - The idle needle (See FIG. 2-8) is usually set one (1) turn open. The setting will vary with operator preference or changing conditions.

2. **HIGH SPEED FUEL** - The fuel supply is limited by a fixed high speed jet. (See FIG. 2-6) The jets are available in various sizes and the optimum size used will depend upon temperature, altitude, etc. A smaller jet permits less fuel flow.

3. **FLOAT** - With fuel bowl removed, and float assembly in place, turn the body casting upside-down so that float assembly is at top. Sight along uppermost surface of float and adjust by bending **metering** lever so that top surface of float is 1 1/16" above body casting surface. (See FIG. 2-12) Adjustment may also be accomplished using the special tool available for this purpose. (See FIG. 2-13)

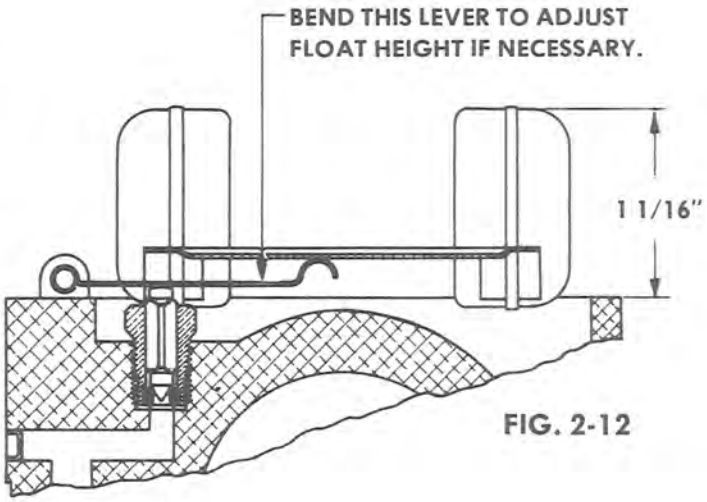


FIG. 2-12

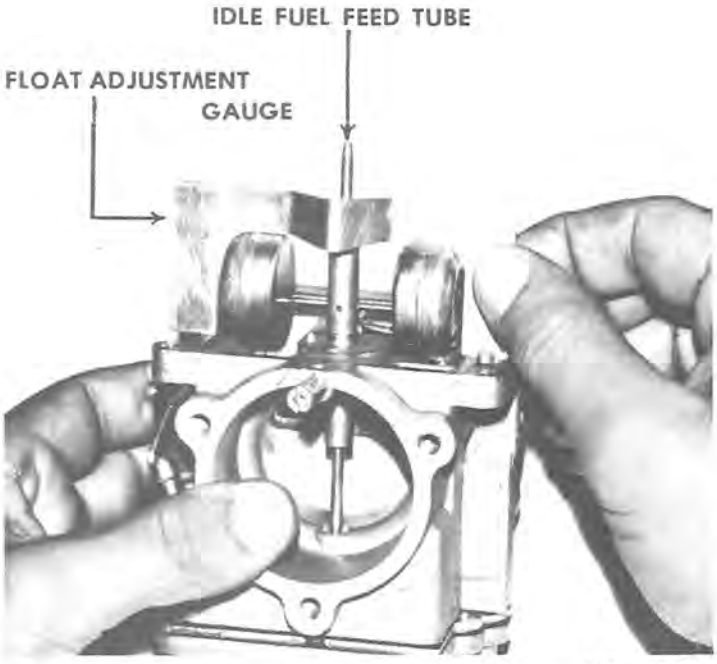


FIG. 2-13

1976
Scorpion
Range Whip

Service Manual

Electrical
Section

ELECTRICAL SYSTEM

The Scorpion Range Whip Electrical System is divided into four (4) subdivisions:

A. Power Generation
B. Ignition
C. Voltage Regulation
D. Electrical Control and Distribution

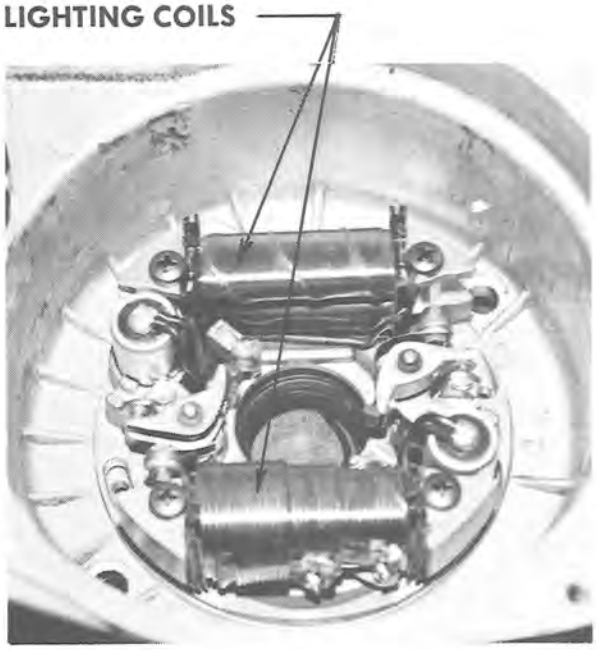


FIG. 3-2

POWER GENERATION

Functional Description:

Electrical AC power, used for lighting and tachometer operation is generated by rotating a permanently magnetized flywheel around two stationary coils (1-120 watt and 1-23 watt). The no-load voltage increases with engine RPM and could reach 32 volts RMS. To maintain the voltage at the required system level (13-14 volts), an external voltage regulator is utilized. (See VOLTAGE REGULATION)

MAIN ELEMENTS:

1. Magnetic Flywheel
2. 120 watt coil (mounted on stator plate)
3. 23 watt coil (mounted on stator plate)

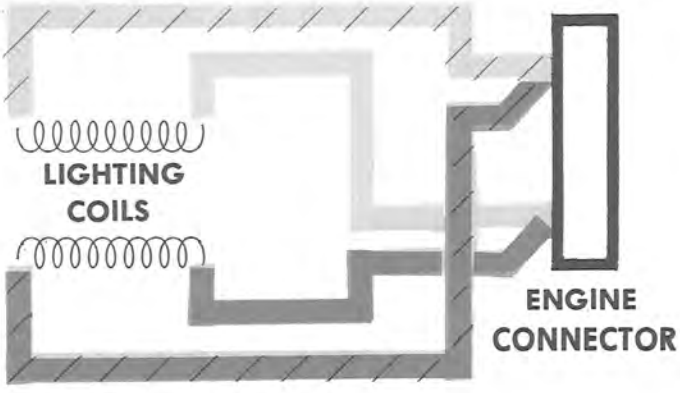


FIG. 3-1 POWER GENERATION SCHEMATIC

FIG. 3-3

IGNITION

Functional Description:
(See SCHEMATIC FIG. 3-7).

magneto type ignition. An electrical current is generated by rotating a permanently magnetized flywheel about the ignition coil. The current initiated in this coil in turn energizes the primary coils of the external ignition coils. The secondary coils of the external ignition coils are situated in the force field generated by the primary coils.

When the points close, causing an interruption of the current flow through the primary winding, its force field immediately collapses and generates a very high voltage in the second coil. This voltage in the region of several thousand volts will jump the spark plug gap causing ignition to begin.

The collapsing lines of force cut through the primary windings, raising the voltage in that circuit also. As this occurs, the condenser absorbs the generated current to reduce the tendency to overload the points. As soon as the voltage level in the primary winding drops below that of the condenser, current again flows in the original direction, energizing the system. This occurrence and the reversal happens several times each cycle creating a powerful, long duration spark for more reliable ignition.

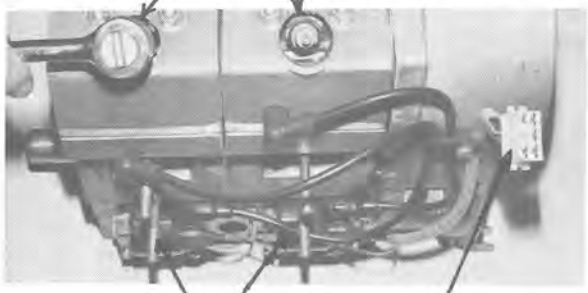


FIG. 3-3

FIG. 3-4

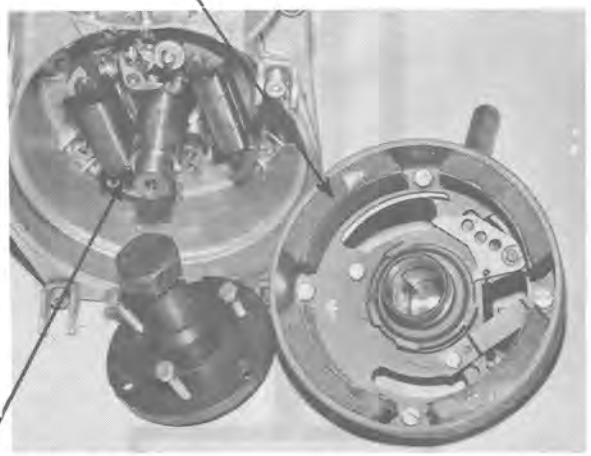


FIG. 3-5

MAIN ELEMENTS:

1. Ignition Coil (Stator)
2. Condensers (2)
3. Breaker Points (2)
4. Ignition Coils (External) (2)
5. Spark Plugs (2)

SEE ENGINE DISASSEMBLY
(SECTION 1) FOR FLYWHEEL
AND STATOR REMOVAL

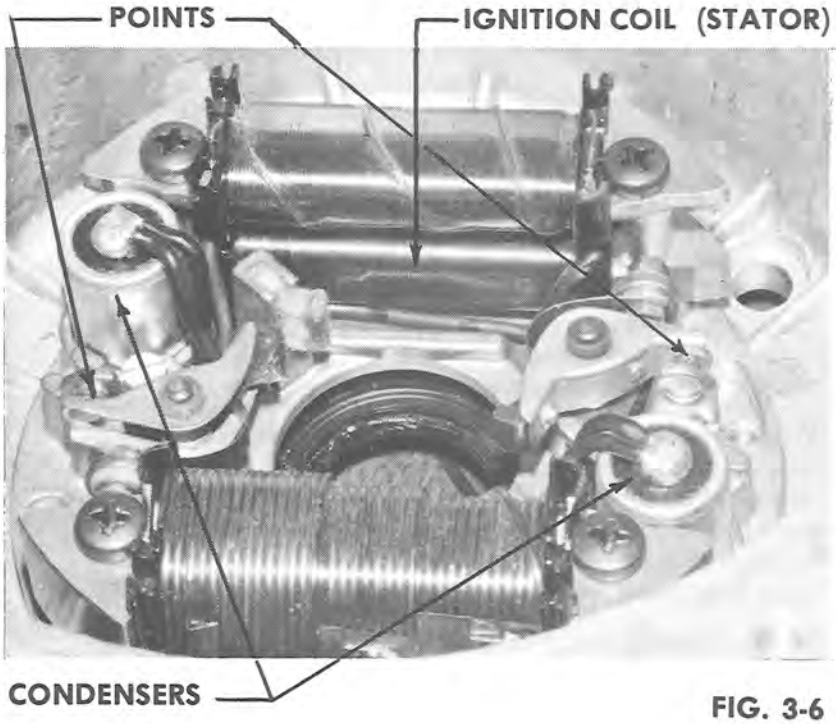


FIG. 3-6

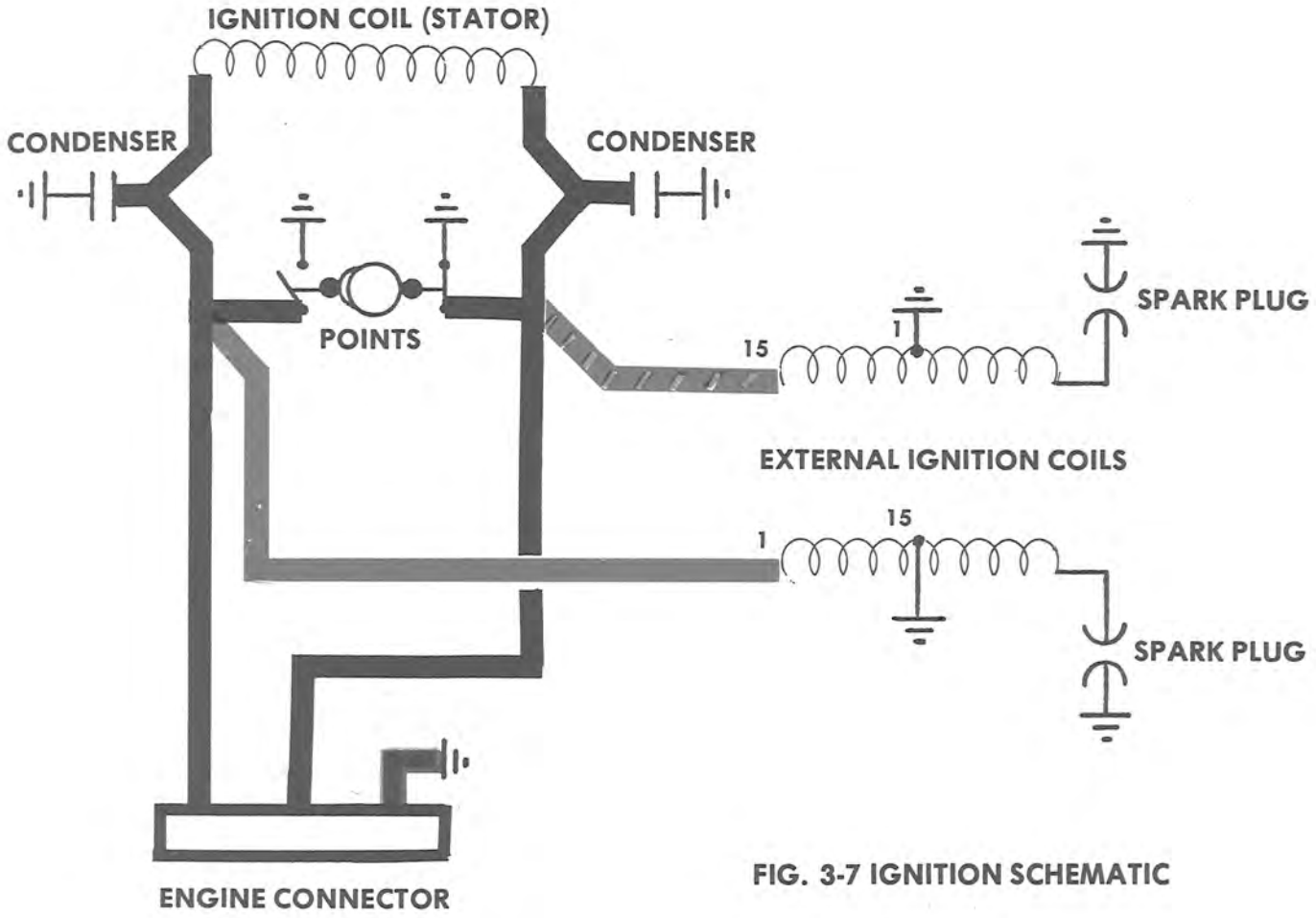


FIG. 3-7 IGNITION SCHEMATIC

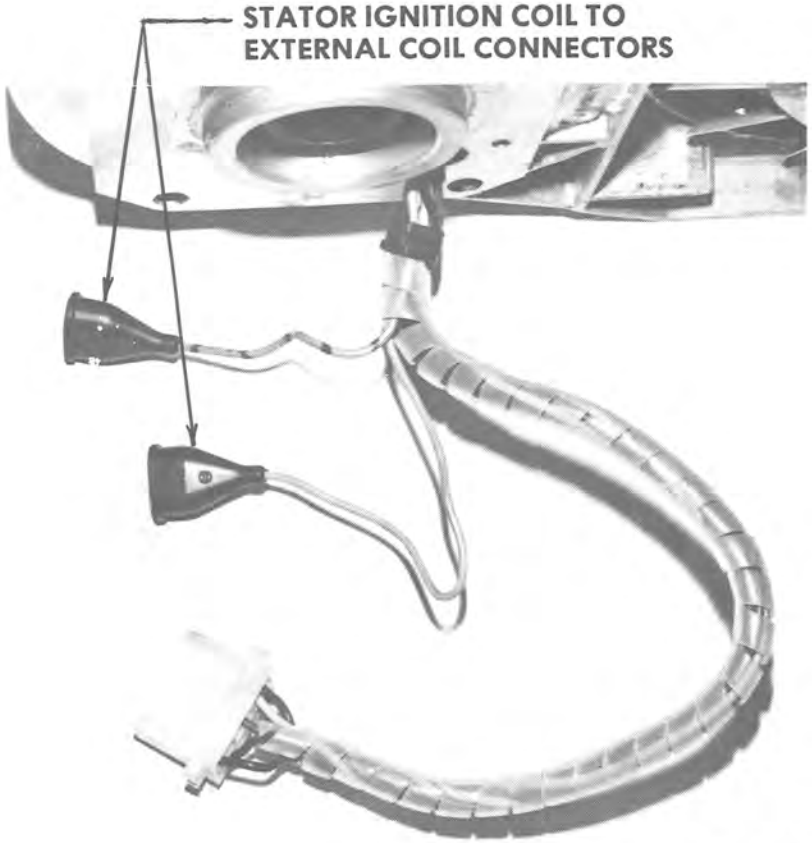

STATOR IGNITION COIL TO
EXTERNAL COIL CONNECTORS

FIG. 3-8

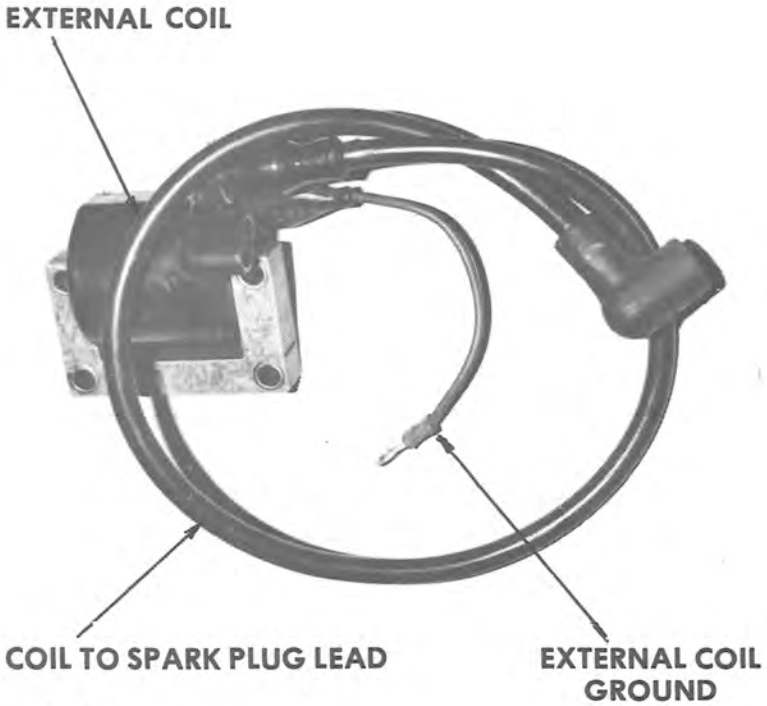

EXTERNAL COIL
COIL TO SPARK PLUG LEAD
EXTERNAL COIL
GROUND

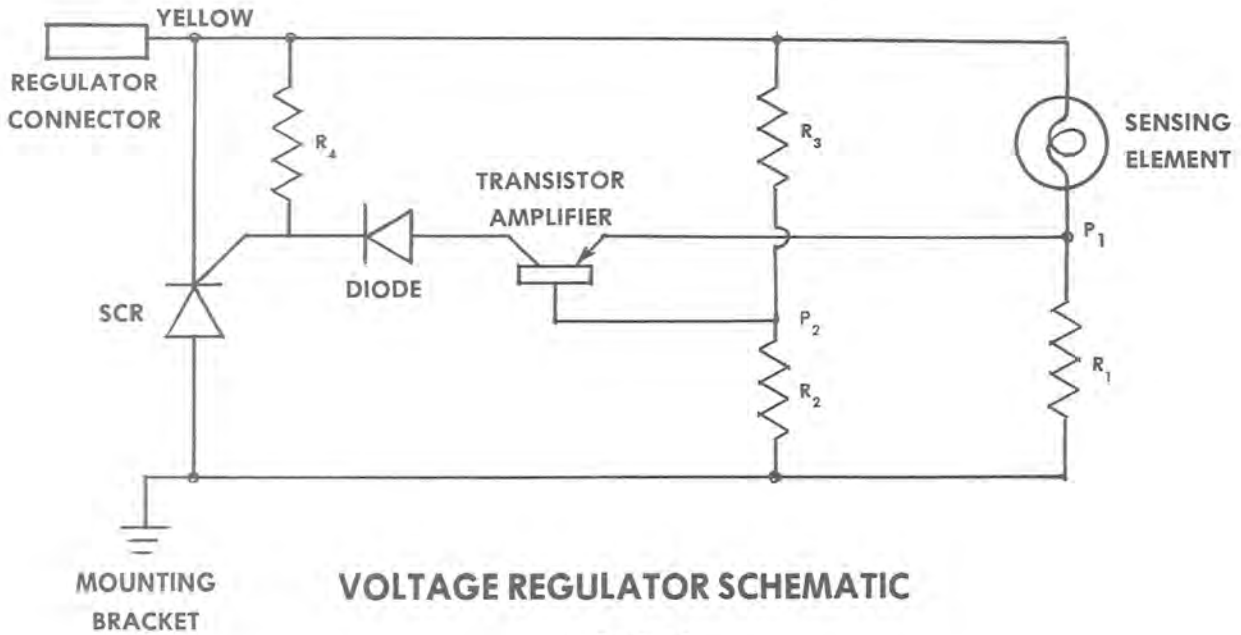
FIG. 3-9

VOLTAGE REGULATION

Functional Description:

The voltage regulator is connected across the lighting coils in parallel with the electrical load of the sled. Under operating conditions, the voltage drop across the regulator is such that 13.8 volts RMS is supplied to the snowmobile lighting circuit.

FIG. 3-11



VOLTAGE REGULATOR SCHEMATIC

FIG. 3-12

VOLTAGE REGULATOR CHECKS

1. Resistance across regulator

   Two most common catastrophic failure modes of the regulator may be identified by simply checking the resistance of the regulator.

   a. Burned out sensing element.

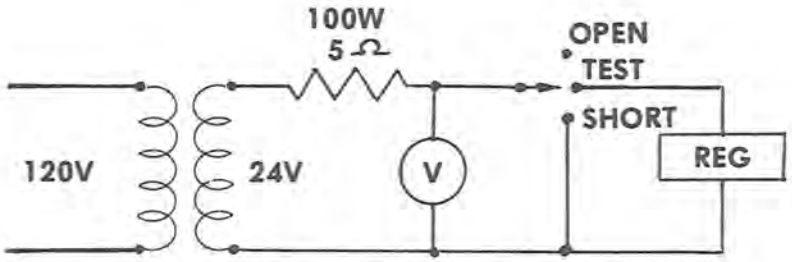
      Normal resistance across the regulator is approximately 155 - 160 . The symptom of a burned out sensing element is a significantly increased resistance reading.

   b. Shorted SCR.

      Shorted SCR is characterized by a significantly reduced resistance reading.

2. Set point check

   Use test circuit as shown below. Read voltage across regulator. Value should be 13.8 ± .5V.



REGULATOR SET POINT TEST CIRCUIT

FIG. 3-12

ELECTRICAL CONTROL AND DISTRIBUTION

Functional Description

Power is supplied continuously to the brake light switch, so that any time power is being generated, the brake light will go on if the brake is applied.

Power to all the other items is supplied through the ignition switch in the "LIGHTS" mode.

Grounding of the System is accomplished at three locations:

1. To the chassis at the rear end
2. To the chassis from wire harness at eng. connector.
3. To the stator plate on the engine

MAIN ELEMENTS:

1. Main Wiring Harness
2. Seat Wiring Harness
3. Taillight Wiring Harness
4. Safety Stop Switch
5. Break Light Switch Hi-Lo Beam Switch
7. Ignition Switch
8. Headlight Harness

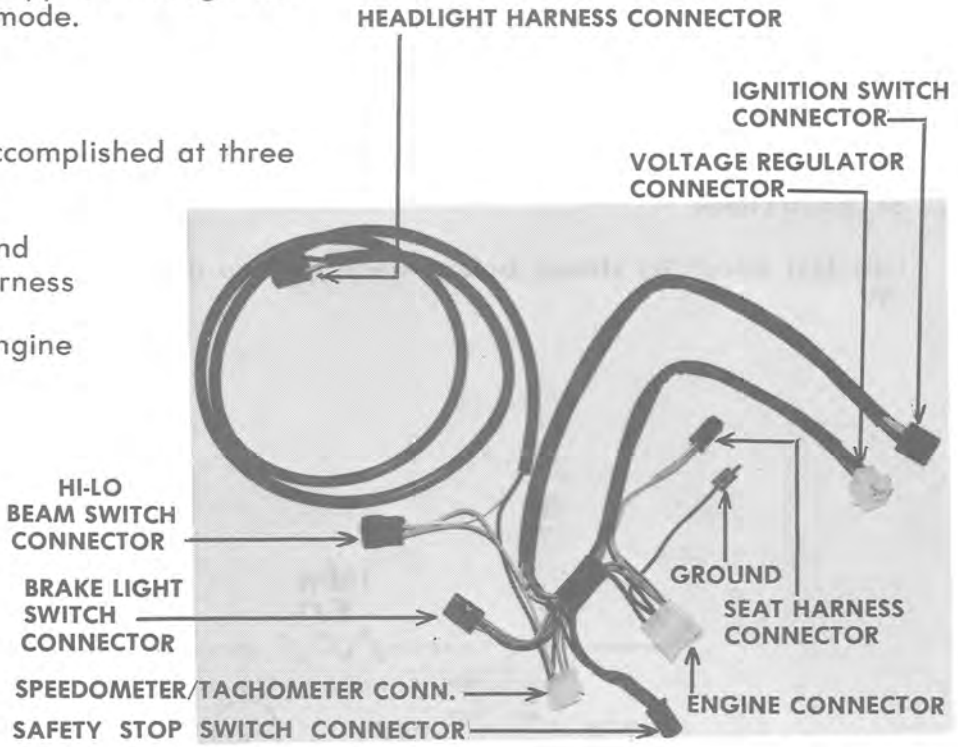


FIG. 3-14

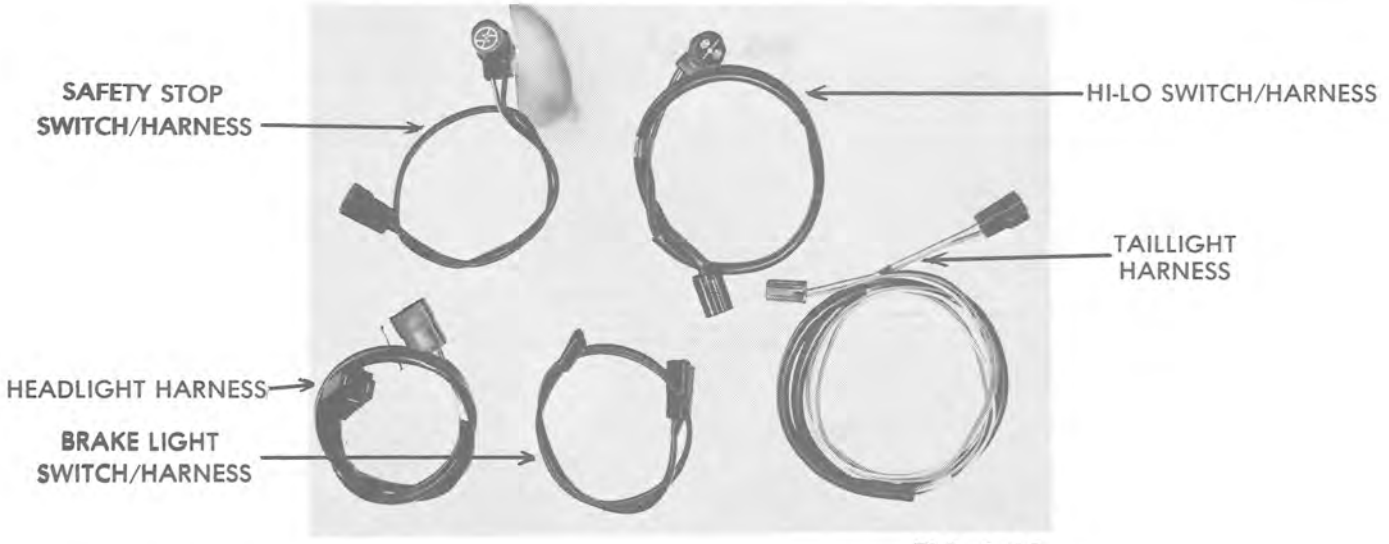
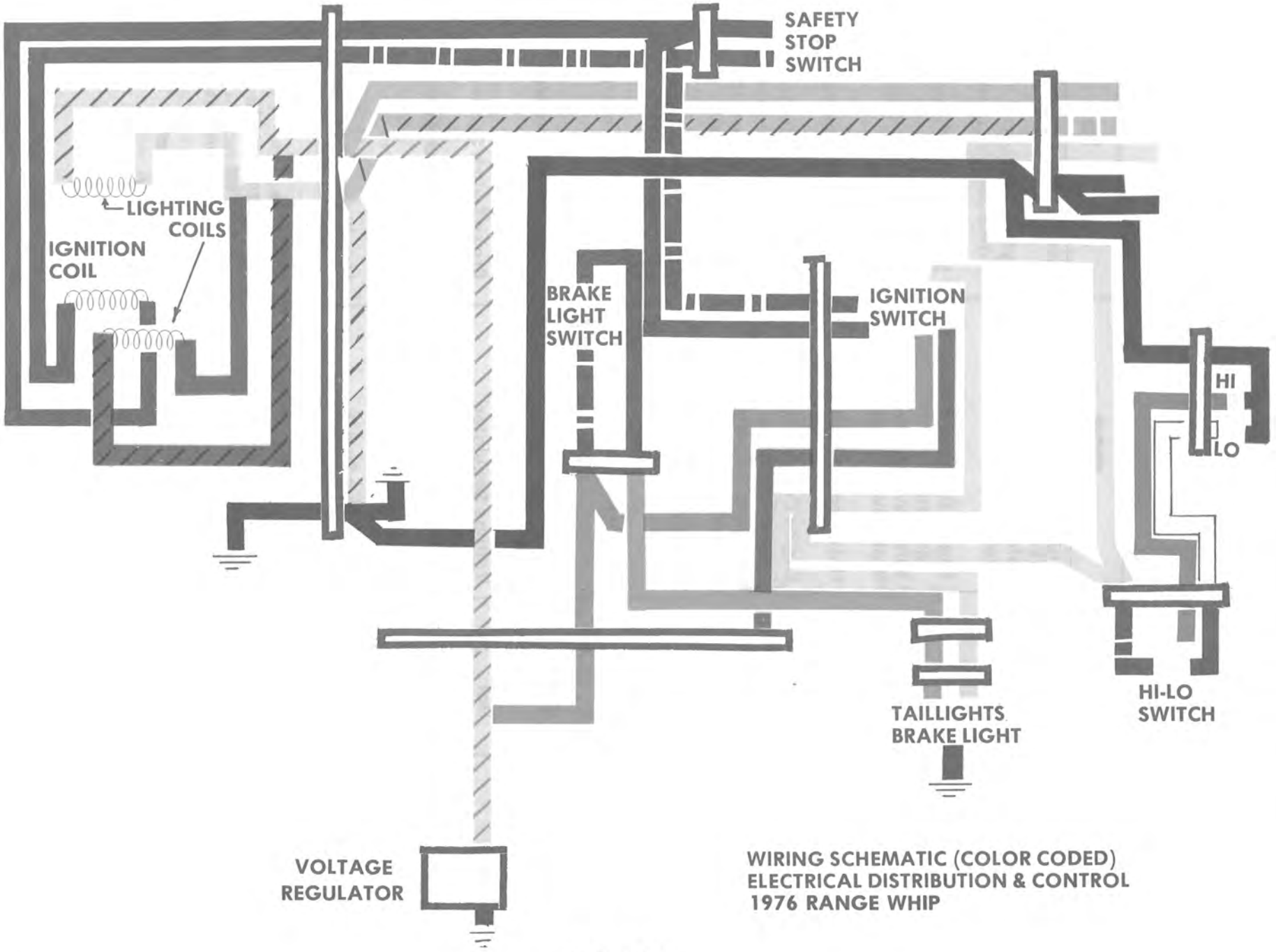


FIG. 3-15



WIRING SCHEMATIC (COLOR CODED)
ELECTRICAL DISTRIBUTION & CONTROL
1976 RANGE WHIP

FIG. 3-15

WIRING CODE (ELECTRICAL DISTRIBUTION & CONTROL)

COLOR	FUNCTION	FROM	TO
Black	Hot	Eng. Connector (Engine Ignition Coil)	Safety Switch Connector
	Hot	Safety Switch Connector	Ignition Switch
	Hot	Brake Switch	Brake Switch Connector
Black/White	Hot	Engine Connector (Engine Ignition Coil	Safety Switch Connector
	Hot	Safety Switch Connector	Ignition Switch Connector
	Hot	Brake Switch Connector	Brake Switch
Blue	Hot (Hi)	Hi-Lo Beam Switch (Hi)	Headlight Connector (Hi)
Brown	Ground	Engine Connector	Chassis (Roll Bar Bracket)
	Ground	Engine Connector	Instrument Connector
	Ground	Instrument Connector	Headlight Connector
	Ground	Taillight	Chassis (Tunnel)
Green	Hot	Ignition Switch Connector	Electric Start (Regulator Connector)
Orange	Hot	Engine Connector	Instrument Connector
Orange/Black	Ground	Engine Connector	Instrument Connector
Red	Hot	Voltage Regulator Connector	Brake Switch Connector
	Hot	Brake Switch Connector	Ignition Switch Connector
Tan	Hot	Brake Switch Connector	Brake Lights
White	Hot (LO)	Hi-Lo Beam Switch Connector (Lo)	Headlight Connector (Lo)
Yellow	Hot	Ignition Switch Connector	Taillights
	Hot	Ignition Switch Connector	Hi-Lo Beam Switch Connector
	Hot	Hi-Lo Beam Switch Connector	Instrument Connector
Yellow/Black	Ground	Engine Connector	Voltage Regulator Connector
Yellow/Red	Hot	Engine Connector	Voltage Regulator Connector

TROUBLE SHOOTING (ELECTRICAL)

TROUBLE	PROBABLE CAUSE	REMEDY
No lights	Open Circuit: Faulty Switch(s) Separated Connector(s) Cut Wiring	Repair or replace faulty or damaged element.
	Wiring shorted to ground: Damaged Insulation	Repair or replace damaged or faulty element.
	Faulty Regulator (Shorted SCR)	Replace regulator.
Dim lights	Shorted or open lighting coil.	Replace armature plate.
	Faulty regulator - Incorrect regulator set point (too low).	Replace regulator.
Burned out lights (all)	Faulty regulator -Incorrect Set Point (too high).	Replace regulator and failed bulbs.
Burned out lights (individual)	Failed bulb.	Replace bulb.
Burned out lights	Intermittent short in wire harness.	Repair or replace wire harness.
Engine won't run Weak or no spark	1. Open or shorted windings in ignition coils (stator). 2. Open or shorted windings. in external ignition coil. 3. Shorted condenser - dirty or worn. 4. Damaged (burned) points.	1. Replace armature plate. 2. Replace external coil. 3. Replace condenser. 4. Replace points.
Engine won't run - Adequate spark.	1. Burned or fouled plugs.	1. Replace plugs. Determine that correct plugs are being used. CHECK ENGINE TROUBLE SHOOTING.
	2. See Engine Trouble Shooting Section	
Unacceptable Engine Performance	See Engine Trouble Shooting Section	

1976 Scorpion Range Whip

Service Manual

Clutch/Drive Section

DRIVE SYSTEM

Functional Description:

The main elements included in this system are:

1. Drive Clutch
2. Drive Belt
3. Driven Clutch
4. Chain Case with sprockets, chain and chain tensioners.
5. Drive shaft with track drive sprockets.

The power from the engine is transmitted through this system to the track in sequence of elements listed above to propel the machine.

The drive clutch, belt and driven clutch serve as a torque converter. The torque converter on the snowmobile "down shifts" to a lower ratio as the track load increases as readily as it "up shifts" when the track load decreases.

To accomplish the automatic shifting, the movable sheave of the driven clutch is fitted with a helical ramp which is guided. This sheave is controlled by a spring pre-stressed in torsion and compression to hold the sheaves together at the **maximum** pitch diameter. The drive clutch cover has a set of centrifugal weights and helical guides. The drive movable contains a mating set of ramps. A spring automatically positions the movable drive clutch at the minimum pitch under zero and idle speed conditions.

Under acceleration, the torque from the engine is greater than the demand from the track. As RPM increases, the weight arms move to force the movable in (away from the cover).

The wedging action of the drive sheaves forces the belt outward in the drive clutch.

Belt tension and wedging action are greater than spring forces of the driven clutch and the sheave faces are wedged open against the helical cam. This action winds up and compresses the spring.

Under steady running, all forces are balanced and the belt chooses a ratio at which this balance exists.

Under deceleration, the driven stationary stalls slightly. The belt tension and friction on the driven movable plus spring torsion, moves the movable along the ramp, closing it and forcing the belt out to a greater pitch diameter. This action increases belt tension. Wedging action opens the drive movable against the weights down the ramps to a new lower pitch diameter for the drive clutch until forces are again equalized.

DRIVE CLUTCH REMOVAL

1. Remove the 7/16" clutch bolt.

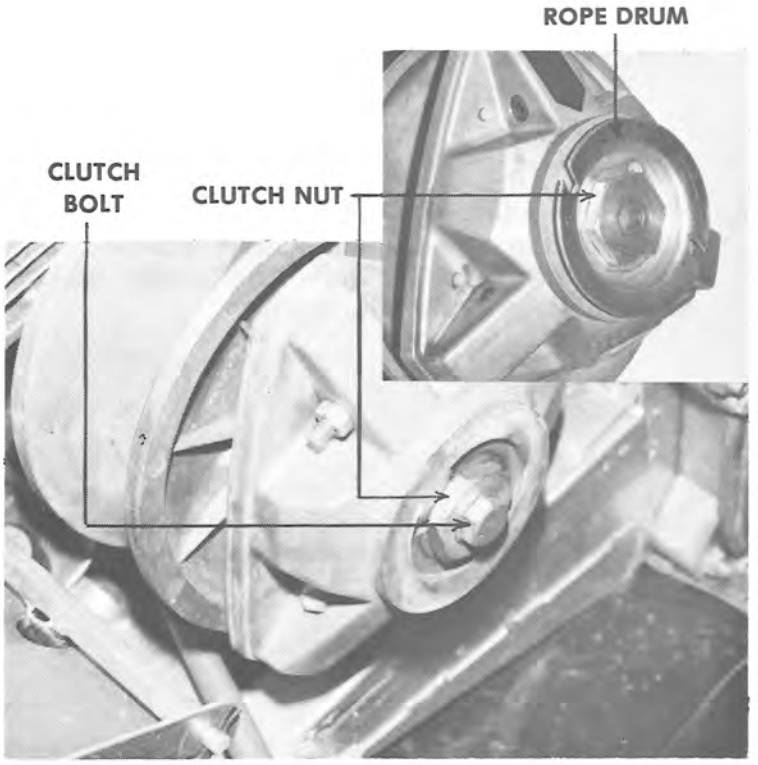


FIG. 4-1

2. Remove large nut (clutch nut) holding clutch together.

3. Insert a 3/4" x 3 3/4" steel plug in hollow drive clutch hub. Use clutch nut with plug as a puller to remove clutch.

FIG. 4-2

DRIVE CLUTCH DISASSEMBLY

1. With clutch removed from sled, install clutch nut approximately one-half (½) way, i.e., one-half the threads engaged.

2. Holding movable firmly with cover facing the floor, rap the nut sharply against the floor (or some other firm object). The cover will separate from the stationary hub.

FIG. 4-3

3. Remove the clutch nut.

   Remove the thrust washer and bearing, movable and cover from the stationary.

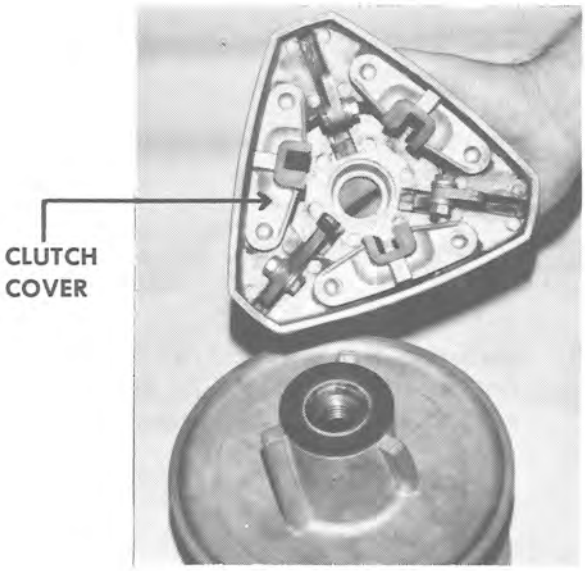


FIG. 4-4

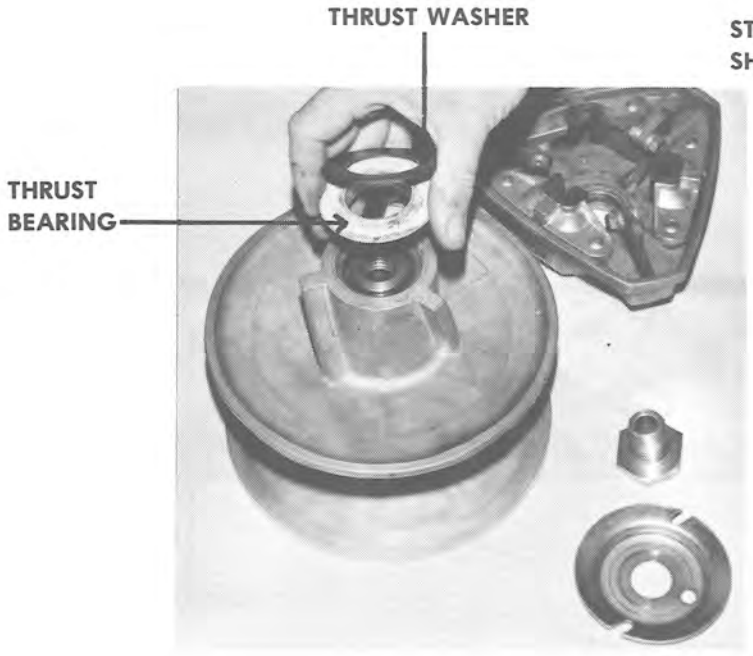


FIG. 4-5

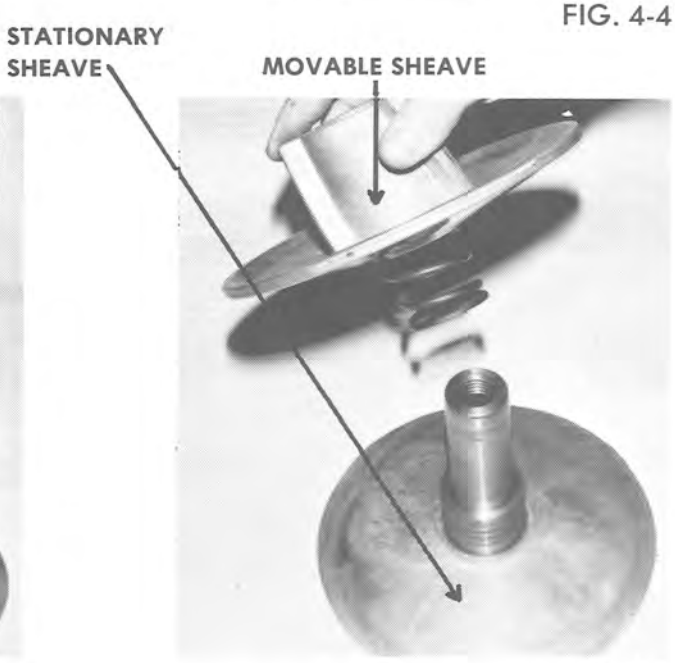


FIG. 4-6

4. Remove spring retainer from movable sheave by aligning with notches in flange of hub.

5. Remove neutral spring in direction of the sheave face. A strong rotating motion in the direction of the spring turns is necessary to extract the spring.

FIG. 4-7

FIG. 4-8

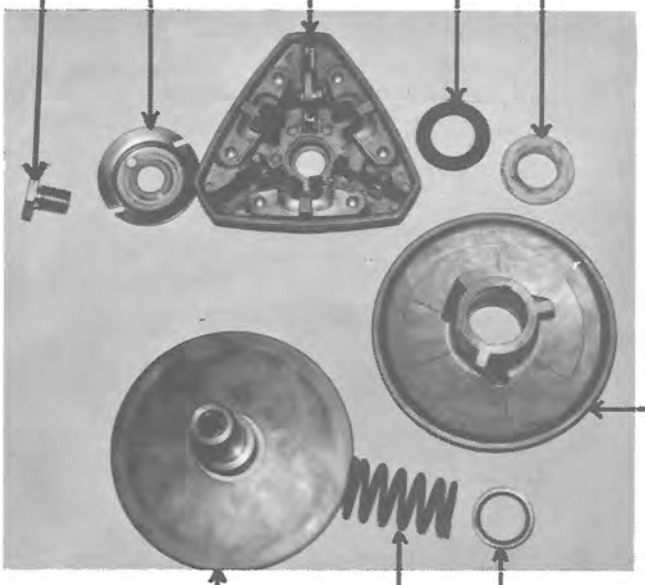


FIG. 4-9

6. Remove wear pads from drive plate in cover manually.

NOTE: Drive pads are riveted to clutch cover and under normal circumstances will never have to be replaced.

7. Remove Allen head screws which secure the weight arms.

   After the Allen head screw is removed, the pivot bushing is pulled out of its recessed area.

   The weight arm assembly is then free to be lifted out of the cover.

NOTE: A special tool is needed to pull the pivot bushing. (See Fig. 4-13).

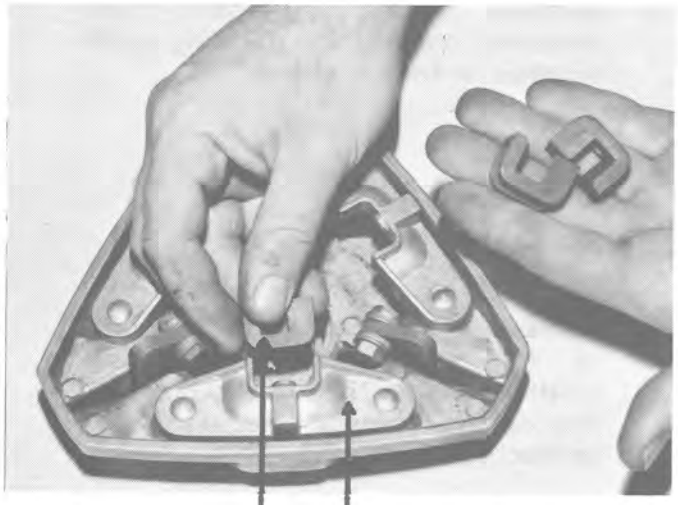


FIG. 4 - 10

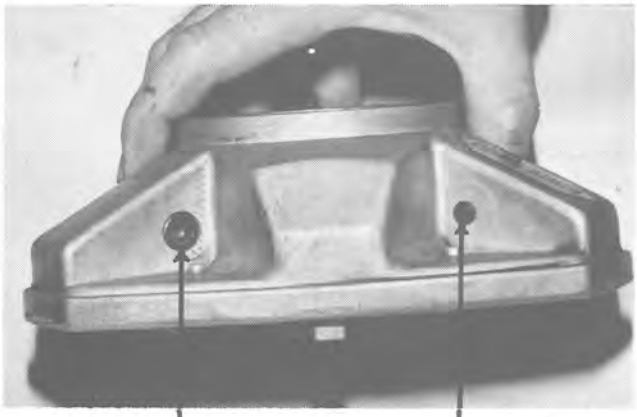


FIG. 4-11

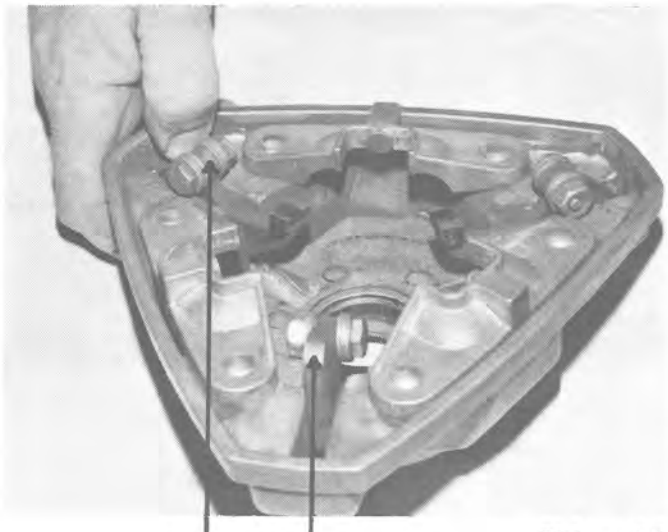


FIG. 4-12

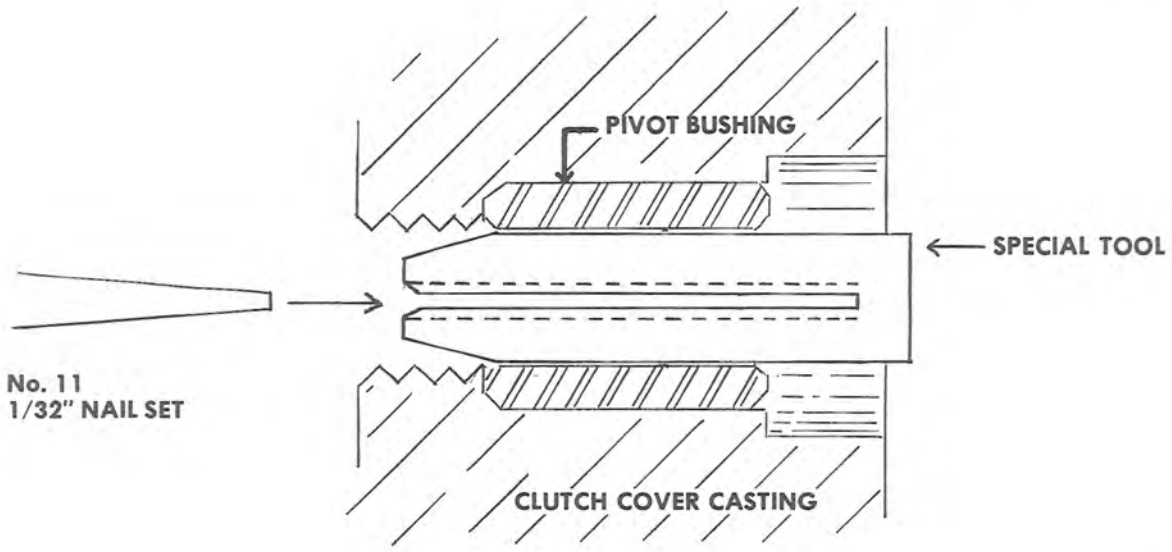


FIG. 4-13

Position puller as shown taking care not to engage threads and insert no. 11 (1/32) nail set through threaded hole into puller. Tapping nail set wedges puller and in the same operation, removes bushing.

8. Punch out the spirol pin and remove the bolt and nut holding the weight washers to completely disassemble the weight arm.

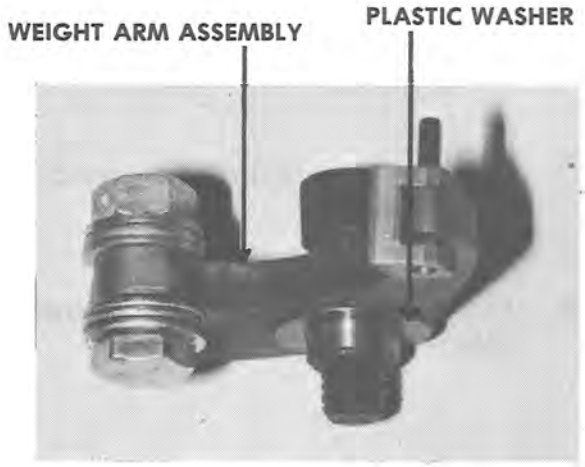


FIG. 4-14

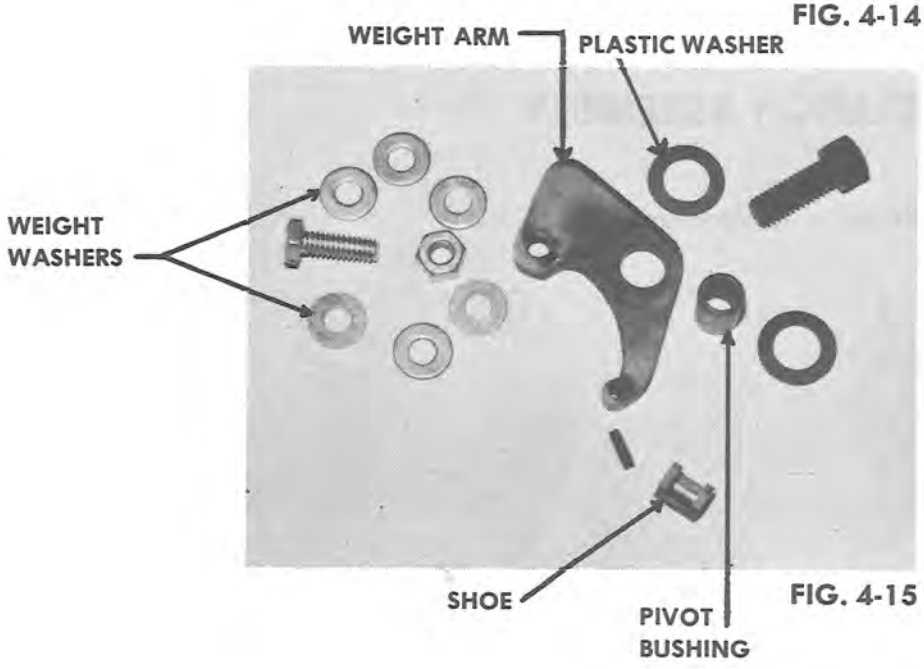


FIG. 4-15

DRIVE CLUTCH ASSEMBLY

COVER

Reverse of disassembly - except that no special tool is required. The pivot bushing is easily inserted.

MOVABLE

1. The neutral spring is installed small end first through the ramp end of the hub. Tapping with a plastic hammer may be necessary to get the spring past the flange of the hub.

2. Push or pull the spring approximately half way down in the hub to provide room for installation of the spring retainer.

3. Retainer installation is reverse of removal. See Fig. 4-7.

4. Force the spring back up against the spring retainer to hold it in position.

CLUTCH ASSEMBLY

Reverse of disassembly.

DRIVEN CLUTCH DISASSEMBLY

1. Remove chain case cover.

2. Remove chain tensioners, unbolt and remove top sprocket and chain .

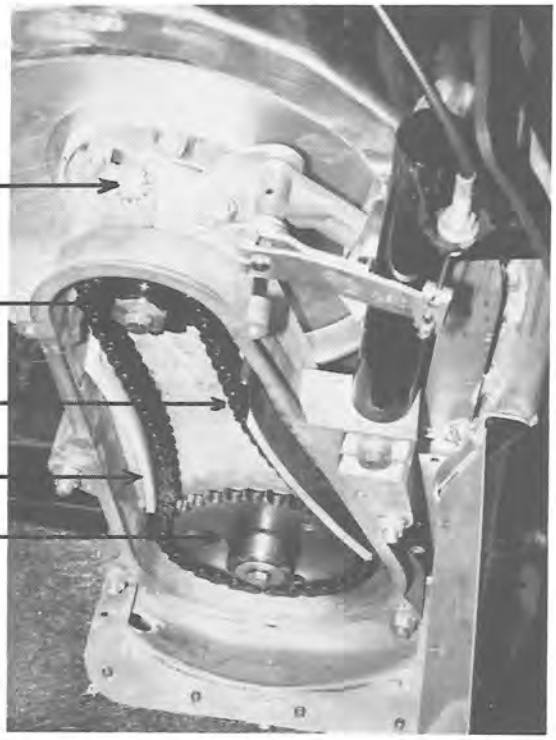


FIG. 4-16

3. Remove driven unit from chaincase (tapping shaft lightly with plastic mallet). Remove snap ring and washer from cam top and slide off shaft. (See Figures 4-17, 4-18, 4-19).

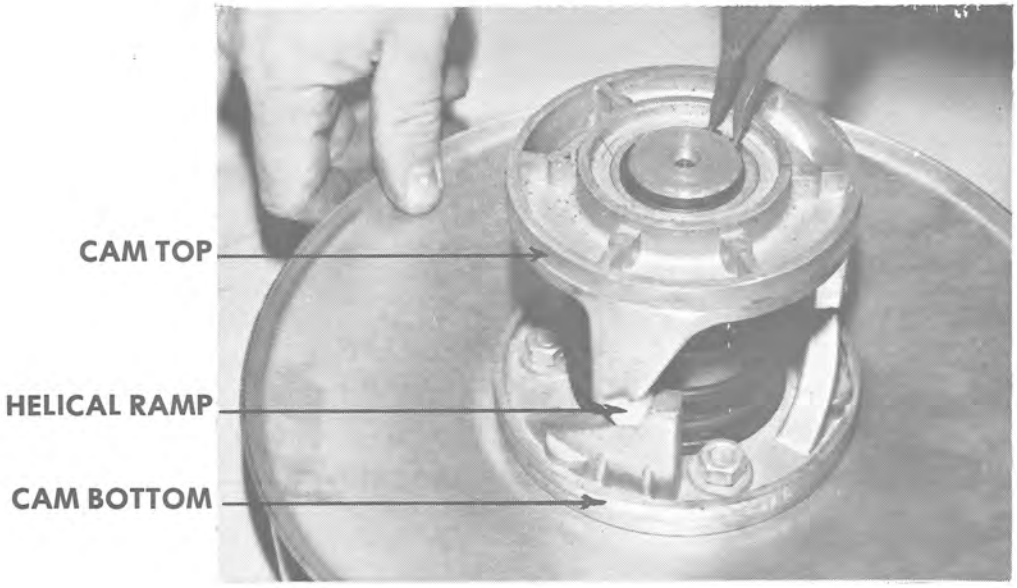


FIG. 4-17

FIG. 4-18

FIG. 4-19

4. Remove key and main spring. (See Figure 4-20).

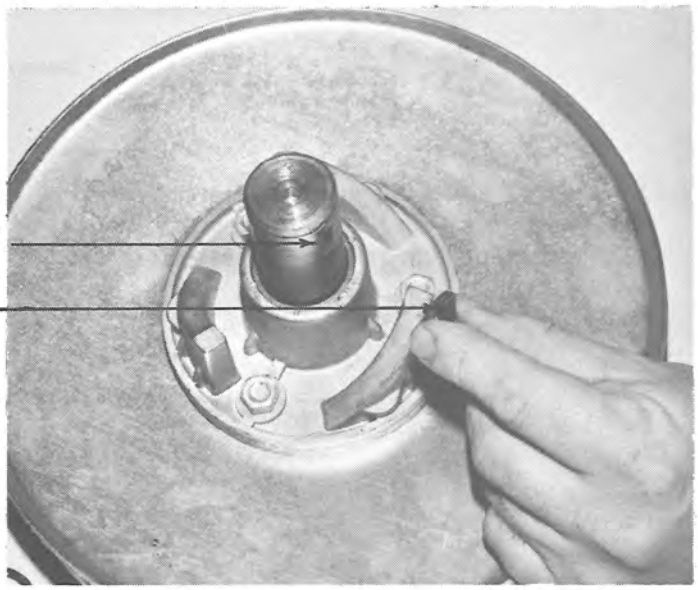


FIG. 4-20

5. This should allow cam bottom and movable sheave to be removed as a unit. NOTE: Take care not to misplace the three spacers located between. (See Figure 4-21), and disassemble if necessary. (See Figure 4-22).

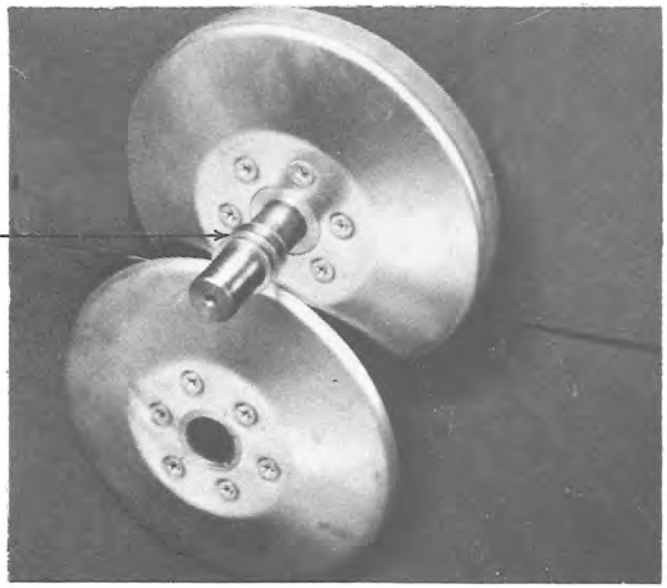


FIG. 4-21

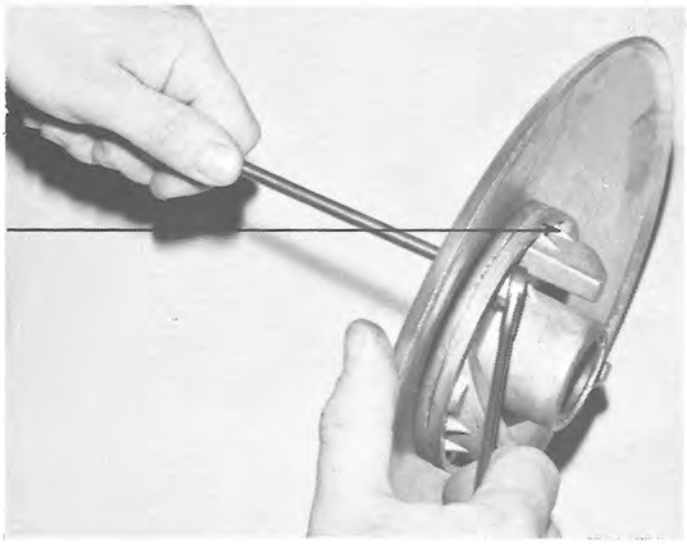


FIG. 4-22

6. Stationary sheave may then be unbolted from clutch shaft (See Figures 4-23 and 4-24) and bearings can be pressed off if necessary.

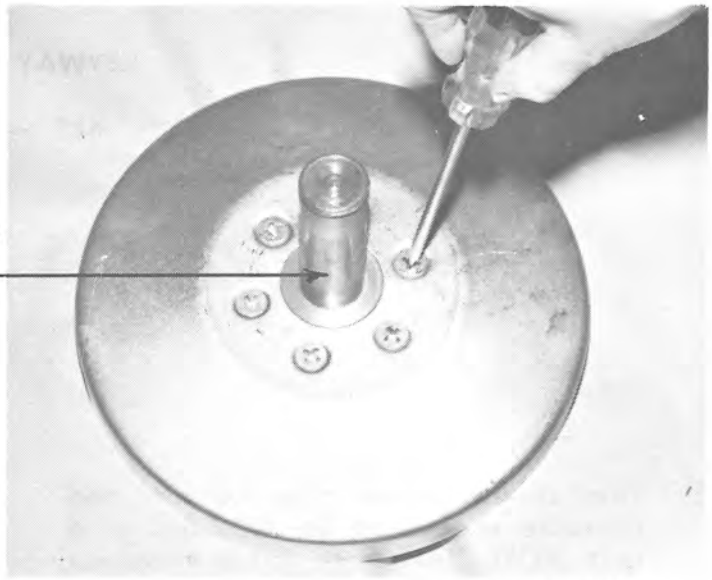


FIG. 4-23

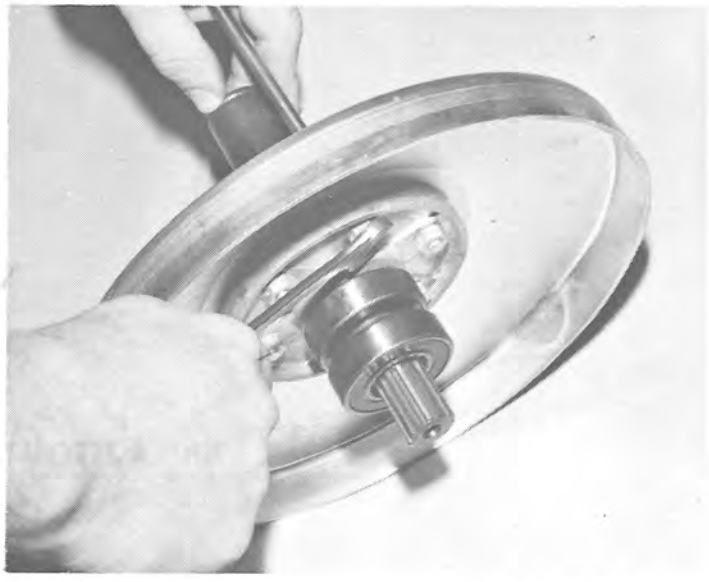


FIG. 4-24

DRIVEN CLUTCH INSPECTION

Inspect snap ring groove for wear.

Inspect Helical ramps for wear and breakage. (See Fig. 4-17).

Inspect bronze bushing in cam bottom for any signs of looseness or slippage (should be staked in solidly).

Rotate and check bearings visually.

Inspect sheaves for cracks particularly around bolt holes.

Check splines and threads on sprocket side of main shaft for wear, crossthreading, etc.

RE-ASSEMBLY OF DRIVEN CLUTCH

Attach stationary sheave to clutch shaft. Assemble cam bottom and movable, then place on shaft followed by the woodruff key and main spring. Place cam top on shaft, preloading spring ⅓ turn and install washer and snap ring.

Upon replacing the driven clutch in chaincase, check to assure that the O-ring in chaincase bore is intact and in good condition. Also check O-ring in chaincase cover before installation.

CHAINCASE DISASSEMBLY

Disconnect brake cable at chain case end. Remove cover, tensioners, upper and lower bolts. Remove sprockets with chain. Remove bearing flange bolts. Taking care to check number of shims between the chaincase and the tunnel and their specific locations, remove the chaincase from the tunnel. When the chaincase is reassembled to tunnel, assure that the spacers go back where they were. Before tightening case to tunnel be sure to adjust case to achieve correct center distance of 10½" between center of driven and drive clutches. Reverse procedure to install.

REMOVAL OF FRONT DRIVE SHAFT

Remove brake cable at chaincase end. Remove chaincase cover, tensioners, lower sprocket and chain. Loosen locking collars on front drive bearings. Remove speedometer, drive adaptor and flanges. Slide drive shaft through chaincase mounting hole until right side clears main frame and remove. (It is necessary to detach forward end of suspension to gain clearance for entire removal of front drive shaft - See Suspension Section.)

REMOVAL OF FRONT DRIVE SPROCKET

Punch out spirol pins. Then taking care to see that the shaft is clean, slide sprockets off.

Observe shaft for signs of stress, cracks and bending, check bearings and collars for breakage. Check sprockets for loosening of pin holes.

NOTE: Small cracks in the white material of the drive sprocket are not signs of failure, but a result of shrinkage during manufacture.

CHAINCASE & FRONT DRIVE REASSEMBLY

To reassemble, reverse disassembly procedures.

DRIVE BELT SPECIFICATIONS

Drive belt width	1 1/8 - 1 3/16 inches
Drive belt outside diameter inches.	43 1/8 - 43 1/4

Clutch offset (Drive to Driven) - 1/2 inches ± 1/32"

Center to center distance - 10½ inches
(Drive clutch to Driven clutch)

TROUBLE SHOOTING

The operating diameter of the drive and driven clutch governs the ratio of reduction or advantage in the snowmobile drive train. Therefore, to gain maximum performance and economy, these areas cannot be overlooked.

The following are some symptoms, causes and cures to aid in trouble shooting the clutch/drive system.

TROUBLE	CAUSE	REMEDY
Engine Overspeed:	Drive clutch may not be closing fully. This can be checked by drawing a line on the face of the sheave (drive or driven) with a crayon from the center outward. Then running the machine at top speed will tell you how far the clutch closed by erasure of the line by the belt.	Disassemble clutches examine and replace malfunctioning parts.
	If the clutch is closing fully, the belt may be wrong length or the center to center distance of the clutches may be off. Finally, check the number of teeth on upper and lower sprockets.	Replace belt. Correct center to center distance (see belt specs.) Replace incorrect sprocket.
	Belt may be worn and too narrow to achieve correct ratio (see belt specification).	Replace belt.
Excessive vibration of drive train:	Track may be too loose allowing sprockets to slip over drive lugs or "ratchet".	Correct track tension.
	Chain may be slipping over teeth on sprockets.	Check and replace broken or weak chain tensioners.
Excessive noise from front drive system:	Malfunction of front drive bearings.	Replace bearings.
	Chain case may be dry of oil.	Disassemble and check - chain, sprockets and chain case cover seal (O ring) replace worn parts and reassemble. Refill with oil check level and check for leaks.

1976
Scorpion
Range Whip

Service Manual

Suspension
Section

FUNCTIONAL DESCRIPTION:

The four main elements of a snowmobile suspension are:

1. Skis
2. Track Suspension
3. Seat
4. Operator

All elements work together to perform the suspension functions to the optimum degree.
The suspensions are basically designed to:

1. Protect the operator from physical abuse or injury.
2. Keep the operator from being ejected from his operating position and controls.
3. Prevent damage to the machine.
4. Increase ground contact and improve traction.

The 1976 Range Whip suspension, a single unit working as a whole, as opposed to the multiple unit bogey suspension, is provided in two types:

1. The "Para-Rail ® Snowmobile Suspension" which has the advantage of being able to traverse marginal snow conditions without damaging effects and

2. The "Para-Slide"T.M. which, with flat track surface and system openness, is especially suited for deep snow and side hill operation.

SUSPENSION SYSTEM

"Para-Rail" ®

(A) REMOVAL

1. Raise and block rear of vehicle off the ground.

2. Remove the two hex cap screws and washers which secure the rear suspension mounting shaft to the tunnel.

3. Drop the back end of the suspension and track from the tunnel.

4. Remove nuts from the two eyebolts.

NOTE:
In Figs. 5-3 through 5-6 the track has been removed for clarity of illustration.

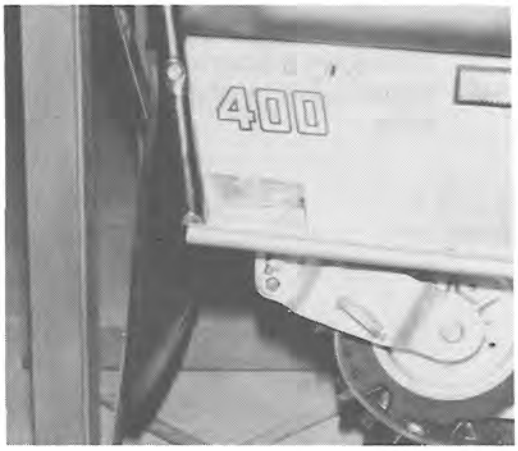
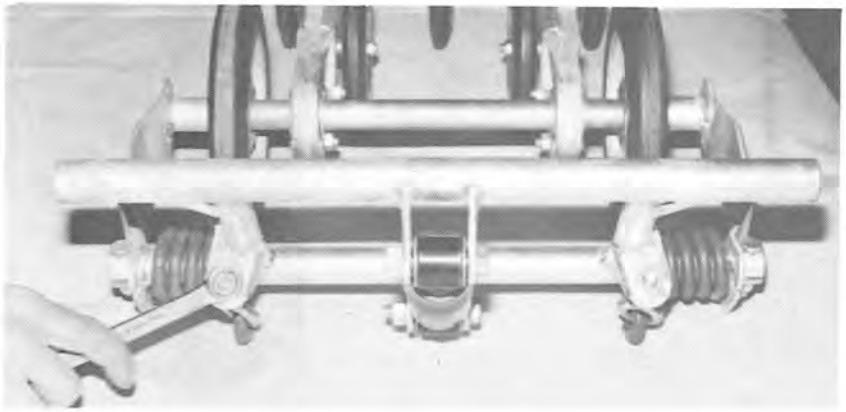


FIG. 5-1

FIG. 5-2



5. Remove the two whiz lock screws, securing the rear suspension plates to the rear axle.

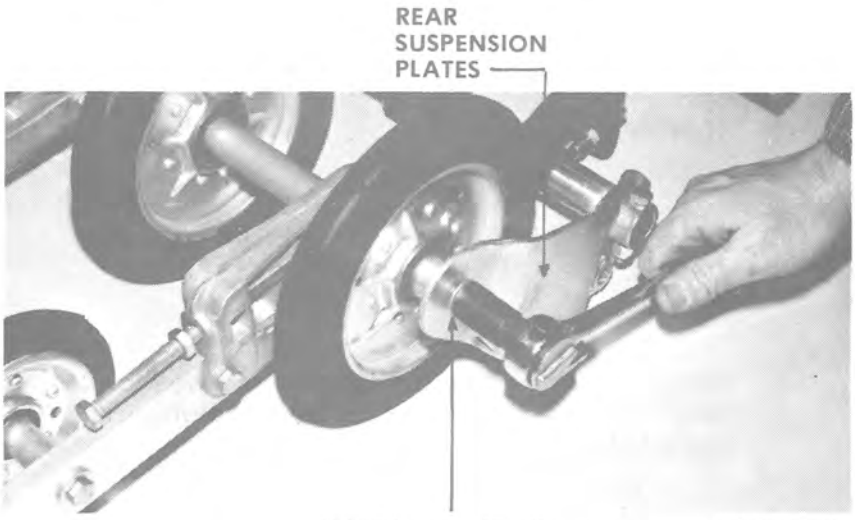


FIG. 5-4

6. Release the track tension by loosening the two screws.

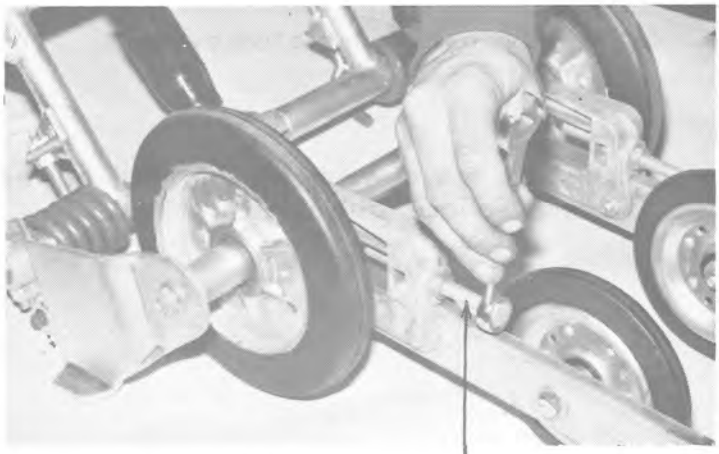


FIG. 5-5

7. Remove hex screws and nuts on the two suspension plates. (See Fig. 5-6.) Remove plates.

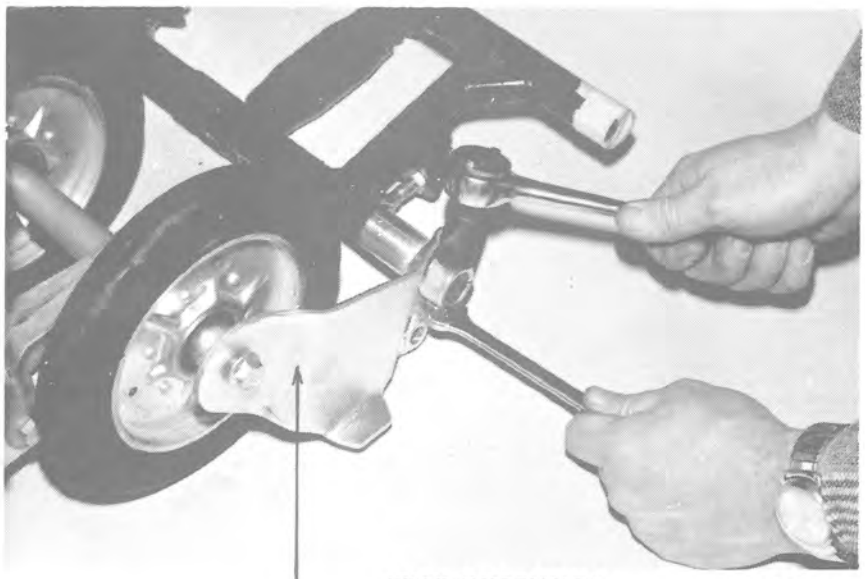


FIG. 5-6

8. Remove the two whiz lock screws located on the side of the tunnel in front of the footrests.

   The "Para-Rail"® can now be removed from the track and tunnel.

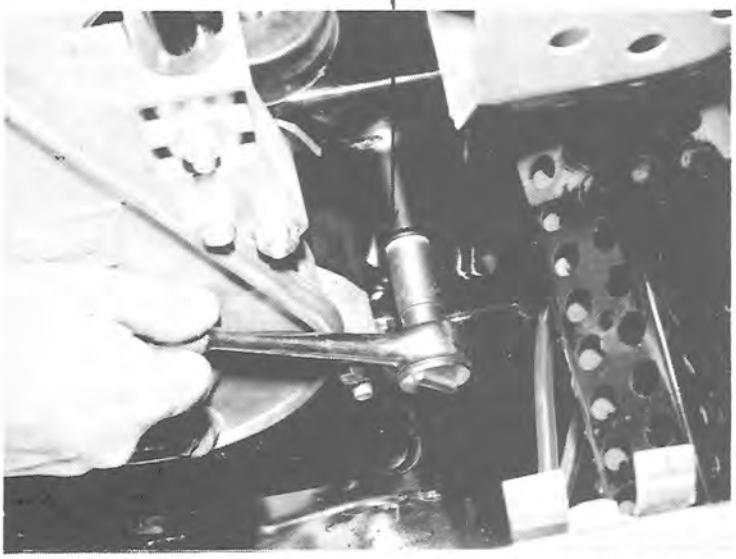


FIG. 5-7

(B) DISASSEMBLY

1. Bracket - axle adjustment.

   Remove the four (4) hex screws and lock nuts.

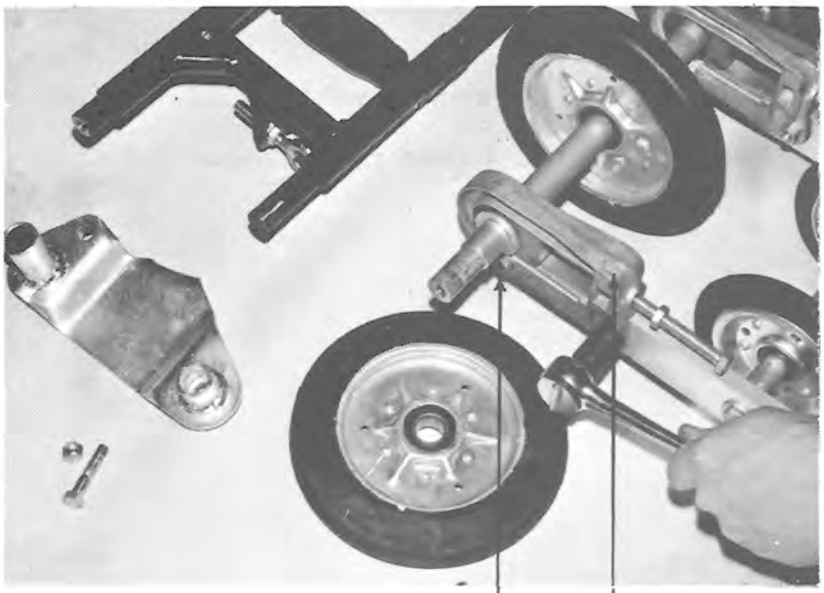


FIG. 5-8

2. Front Suspension Springs.

   Place suspension on the floor and install spring release tool.

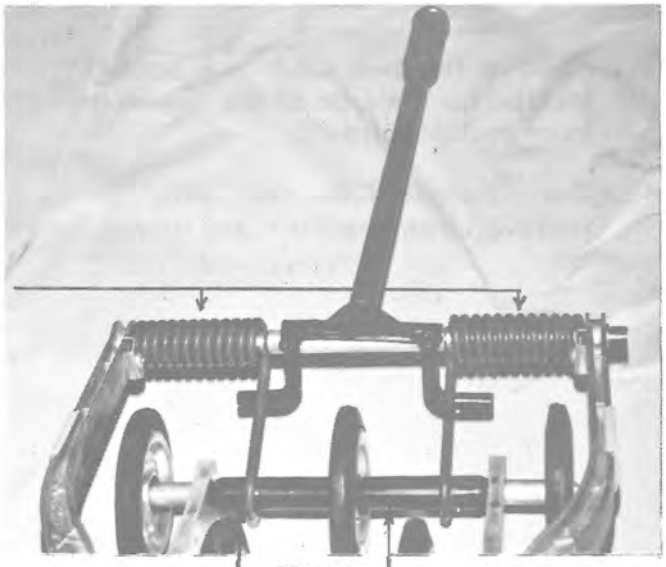


FIG. 5-9

To release the springs from the spools the rear of "Para-Rail® - Snowmobile Suspension" must be held down while downward pressure is applied with the right arm and upward pressure with the left arm.

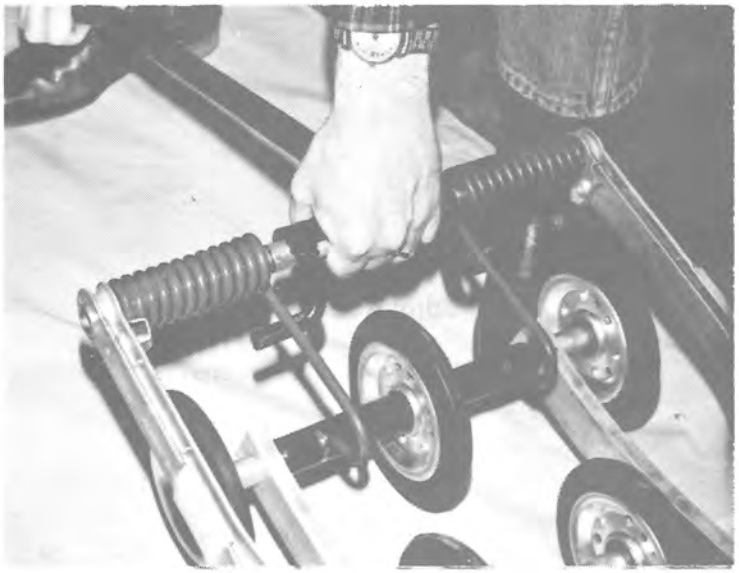


FIG. 5-10

3. Linkage Arm.

   Remove the two screws and washers.

   Remove the two button head screws and spring retainers.

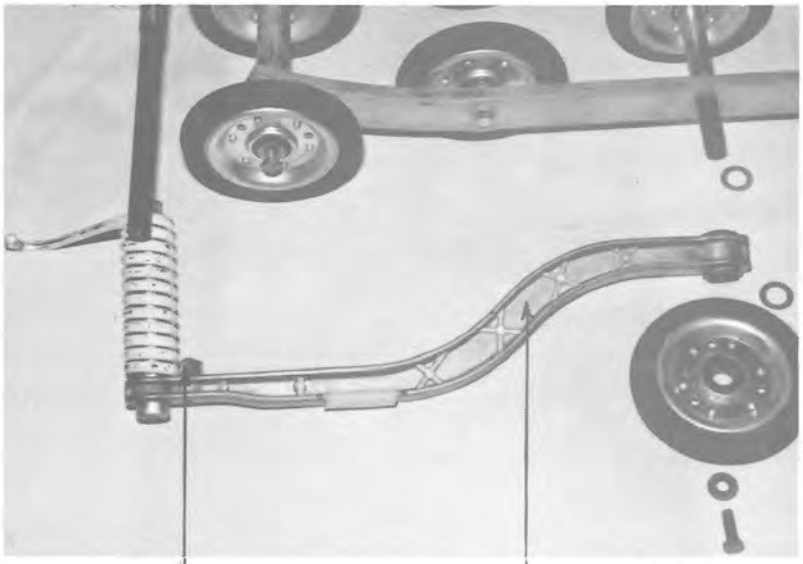


FIG. 5-11

4. Bogey Wheel.

Remove the shaft. This will allow the bogey wheel, tube spacers, bearing, and remaining washers to be free from suspension. (Fig. 5-12.)

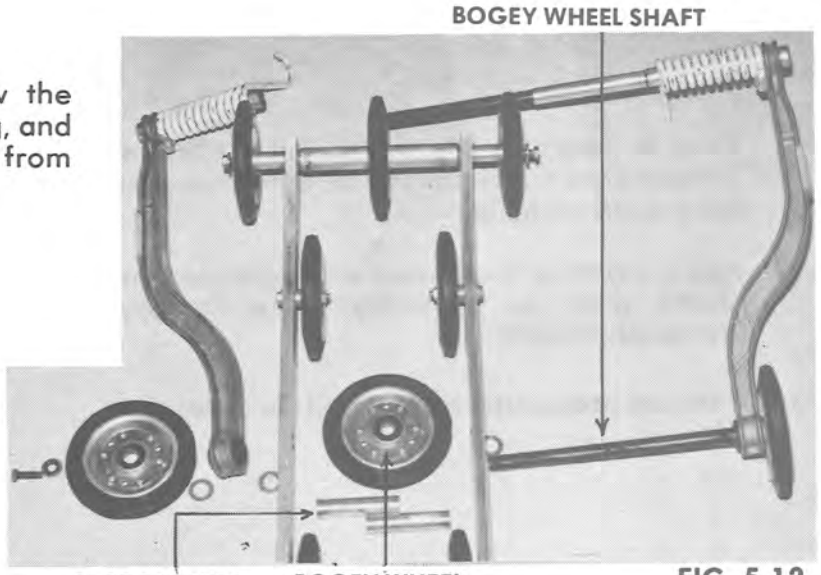


FIG. 5-12

5. Spools.

Remove the two screws and washers from the wheel shaft. Push shaft through rails and spools are removed. (Fig. 5-13.)

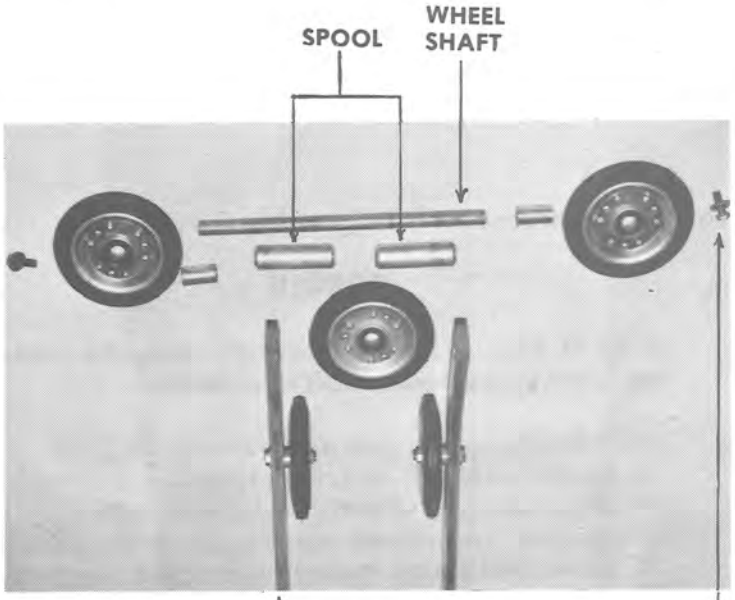


FIG. 5-13

6. Rails.

Remove the remaining eight (8) screws and washers. This will allow the rails to be removed from the remaining shafts, bogey wheels, and tube spacers. The "Para-Rail® - Snowmobile Suspension" is completely disassembled at this time.

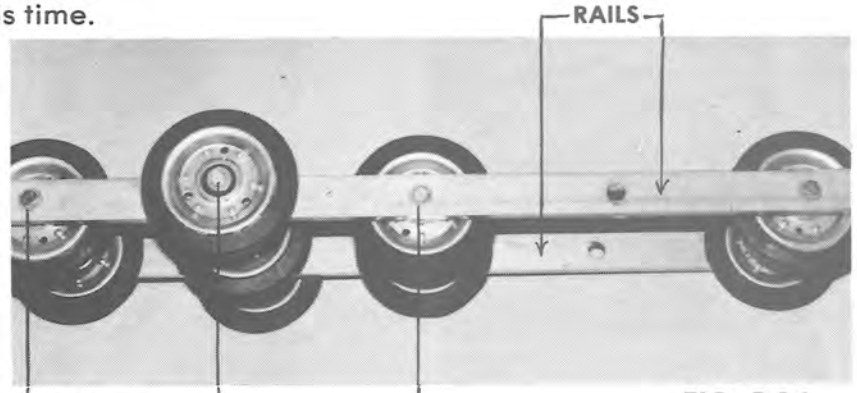


FIG. 5-14

(C) ASSEMBLY

1. Prior to assembly procedure, ensure that all components are clean and all defective parts have been replaced.
2. Apply a coat of low temperature grease to all shafts prior to assembly. (Use Scorpion clutch lub 906800.)
3. Reverse procedure as outlined for disassembly.

NOTE: Ensure that all tube spacers and bogey wheels are assembled in their respective areas on the shafts.

Torque requirements for assembly are:

TORQUE

50-60 Ft.-Lbs. — Screws securing rear idle wheels and front suspension shaft in position.

15-19 Ft.-Lbs. — Screws and nuts which:
fasten axle adj. brackets to rails,
secure bogey wheels and shafts, and
secure suspension pivot shaft to suspension plate and shock mounting bracket.

SPECIAL ADJUSTMENTS -"PARA-RAIL" ®

REAR SPRING ADJUSTMENT

The rear spring adjustment governs preload and should be correlated with the weight of the rider or riders normally using the machine.

Too much spring tension will result in a harsh ride and increases the weight carried on the skis, thus increasing steering effort.

Too little spring tension will result in the bottoming out of the suspension, a harsh ride and shortened life to the suspension components will occur.

1. The proper spring tension may be obtained by having the rider(s) sit on the machine, in the normal sitting position and measure the distance between the floor and the bottom of the running board at the rear of the machine (either side). This measurement must be 4½" to 6".

2. To adjust, loosen the nuts on the eye bolts and adjust accordingly, making certain that each spring is tightened or loosened the same amount.

3. Repeat Step 1, and tighten the nuts on the eye bolts securely when the 4½" to 6" measurement is attained.

NOTE: When 300 lbs. (combined passenger weight) is normally carried on machine, a "heavy duty" spring kit should be installed on machine. This kit is available at your Scorpion Distributor as an accessory item.

FIG. 5-15

TRACK TENSION ADJUSTMENT

Proper track tension is extremely important to assure long life of all associated components and efficiency of the track drive system.

The track tension should be checked at the following intervals:

1. When the machine is new (dealer preparation).
2. After the first 10 hours.
3. Every 30 days, or 200 miles of operation.
4. At the start of each snow season.

The following procedure applies to all "Para-Rail ® - Snowmobile Suspension" equipped Scorpion snowmobiles:

1. The track should be at room temperature or should have been recently run to remove any stiffness, caused by cold weather.
2. Elevate the rear of the machine.
3. Adjust each "Track Jack" to one and one quarter inch (1¼).
4. Insert both "Track Jacks" between the track and both bogey wheels, located on the third bogey axle, ahead of the rear idler wheels.
5. If the track is properly tensioned, the green ring should be just visible or aligned with the lip of the cylinder. Adjustment is required if the green ring is not visible, or is above the lip of the cylinder.
6. To make adjustment, loosen the lock nuts on the track adjustment bolts, as well as the rear suspension mounting screws (rear of tunnel just below seat), and either tighten or loosen the adjustment bolts until proper adjustment is measured on both "Track Jacks" (green ring aligned with lip on cylinder).
7. Retighten the lock nuts on the track adjustment bolts, as well as the rear suspension mounting screws.

NOTE: Track Jacks" are available at Scorpion, Inc. It is an accessory item, Part #901736.

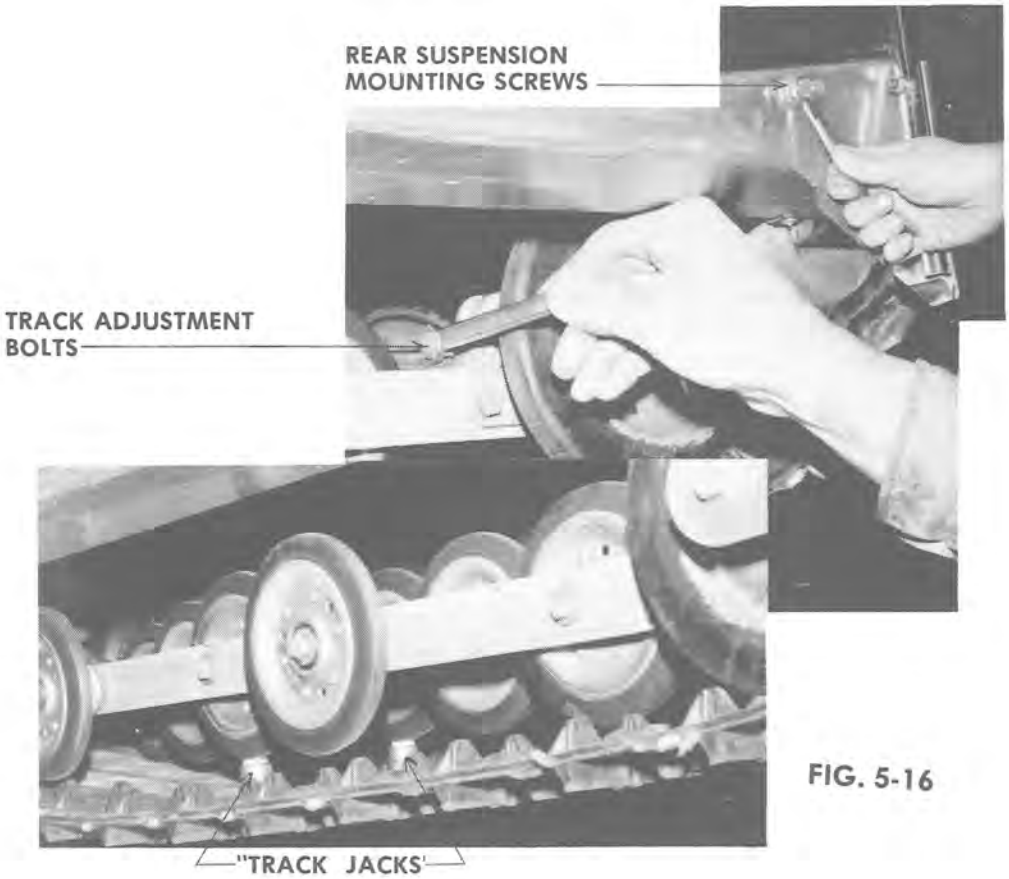


FIG. 5-16

IN THE EVENT "Track Jacks" are not available, the following procedure may be employed to achieve track tension:

1. The track should be at room temperature or should have been recently run to remove any stiffness, caused by cold weather.
2. Elevate the rear of the machine.
3. Apply ten (10) lbs. of force or weight evenly distributed across the track under both bogey wheels, located on the third bogey axle, ahead of the rear idler wheels.
4. To make adjustment, loosen the lock nuts on the track adjustment bolts, as well as the rear suspension mounting screws (rear of tunnel just below seat), and either tighten or loosen the adjustment bolts to achieve the 1¼ inch clearance between track and bogey wheels.
5. Remove ten (10) lbs. force or weight and retighten the lock nuts on the track adjustment bolts, as well as the rear suspension mounting screws.

SUSPENSION SYSTEM
"PARA-SLIDE" T.M.

(A) REMOVAL

1. Raise and block the rear end of the vehicle off the ground.

2. Remove the two cap screws and washers which secure the rear suspension mounting shaft to the tunnel.

3. Drop the back end of the suspension and track from the tunnel.

4. Remove nuts from the two eye bolts.

FIG. 5-17

NOTE:
In Fig. 5-19 and 5-10 the track has been removed for clarity of illustration.

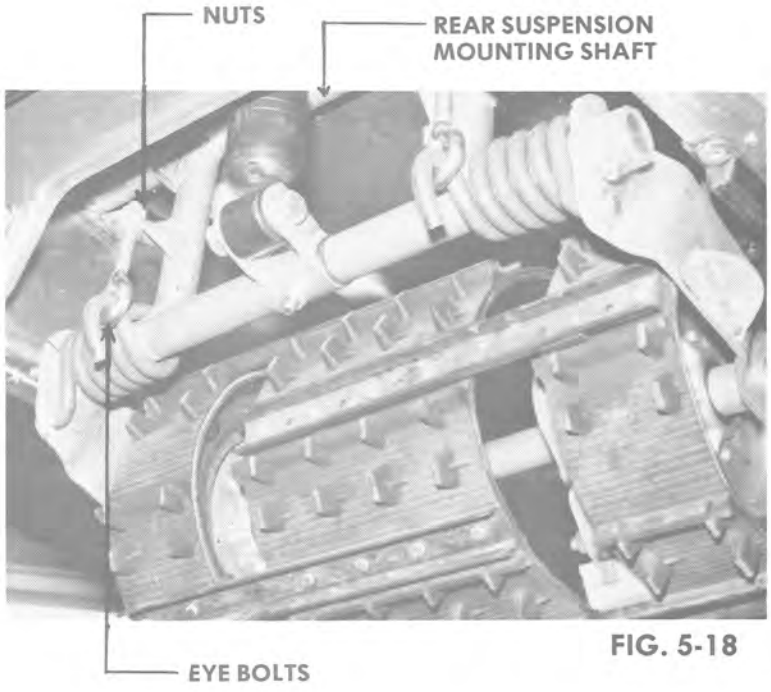


FIG. 5-18

5. Remove the two whiz lock screws securing the rear suspension plates to the rear axle.

6. Release track tension by loosening the two track tension adjusting screws.

7. Remove the hex screws and nuts which fasten the rear suspension plates to the rear suspension weldment.

   Remove the rear suspension plates.

8. Remove the two whiz lock screws located on the side of the tunnel in front of the footrests which secure the front pivot shaft to the tunnel (See Fig. 5-7).

9. Remove the Para-Slide from the tunnel and track.

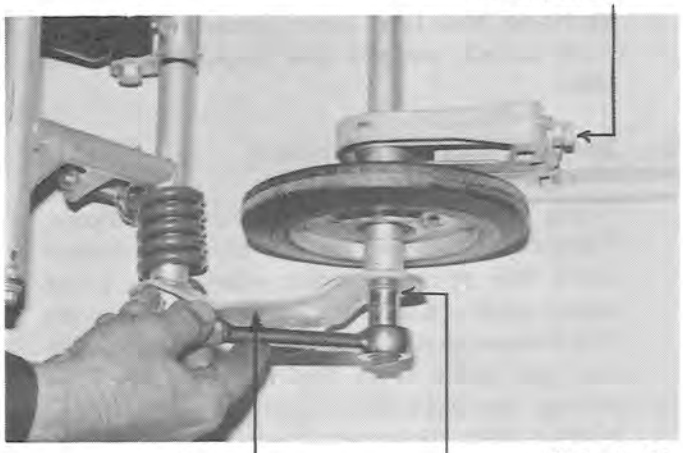


FIG. 5-19

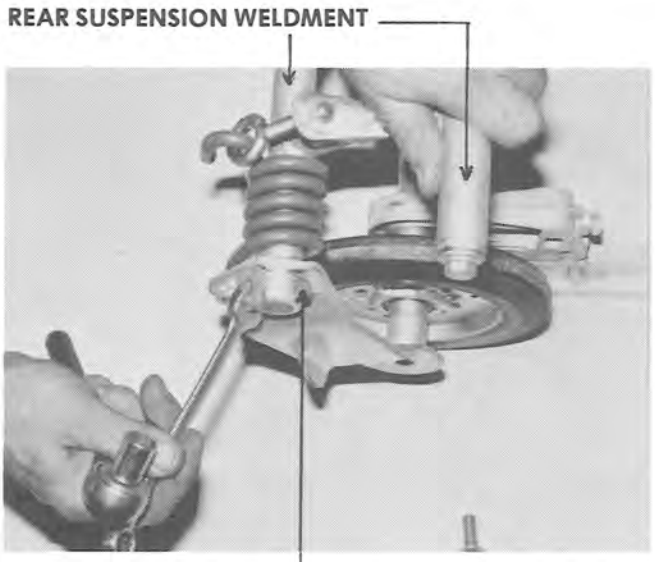


FIG. 5-20

(B) DISASSEMBLY

1. Bracket - axle adjustment.

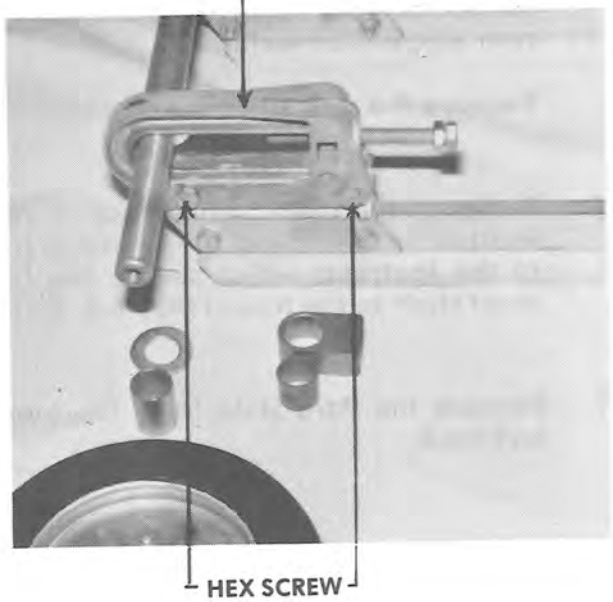
   Remove the four hex screws and lock nuts which secure the brackets to the rails.

2. Springs - front suspension.

   Place the suspension flat on the floor. Push down on the torque arm weldment until the spring hooks clear the front cross shaft. Keeping pressure down on the torque arm with one hand, grasp the spring hooks with the other hand and swing the assembly upward so that the hooks clear the cross shaft.

3. Torque Arm Weldment

   Remove the two hex head screws that fasten the torque arm weldment to the rail assembly.



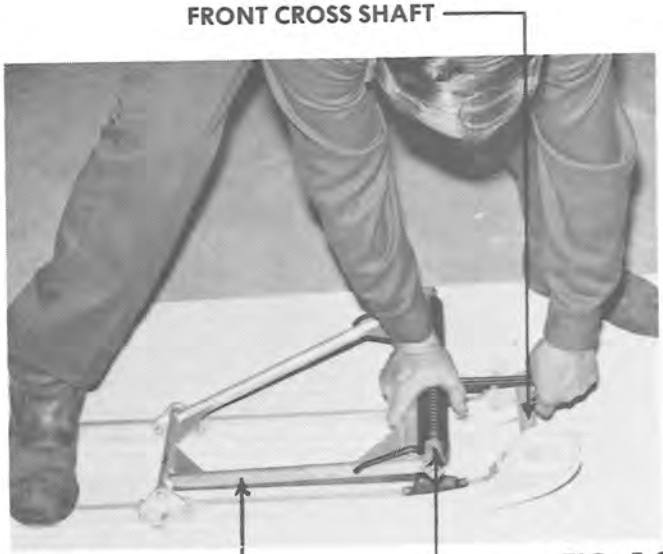


FIG. 5-22

4. Rail Assembly.

   Remove the screws which secure the front cross shaft to the rails.

   Remove the screw which fastens the wear strip to the rail. Slide the wear strip off the rear end of the rail.

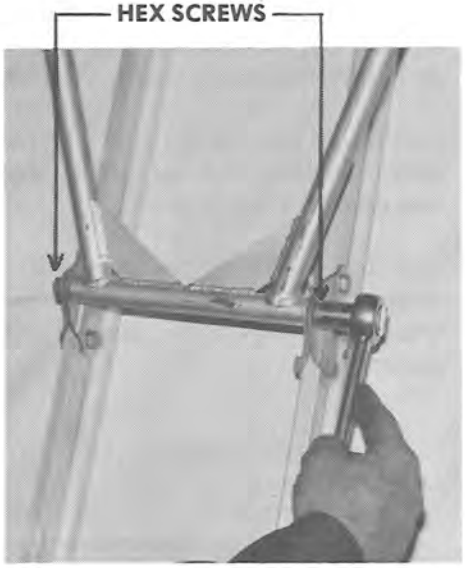


FIG. 5-23

(C) ASSEMBLY

1. Prior to assembly, insure that all components are clean and all worn or damaged parts have been replaced.

2. Apply a coat of low temperature grease to all shafts prior to assembly (use Scorpion clutch lube 906800).

3. Reverse procedure as outlined for Disassembly.

TORQUE REQUIREMENTS FOR ASSEMBLY ARE:

TORQUE	ITEM
50-60 Ft.-Lbs.	Screws & nuts which fasten axle adj. brackets to rails, secure torque arm weldment & cross shafts to rails.
15-19 Ft.-Lbs.	

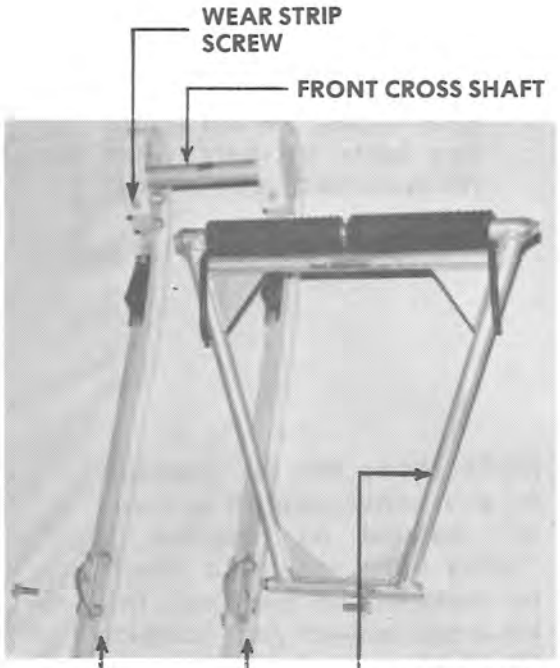


FIG. 5-24

SPECIAL ADJUSTMENTS - "PARA-SLIDE" T.M.

REAR SPRING ADJUSTMENT

The rear spring adjustment governs preload and should be correlated with the weight of the rider or riders normally using the machine.

Too much spring tension will result in a harsh ride and increases the weight carried on the skis, thus increasing steering effort.

Too little spring tension will result in the bottoming out of the suspension, a harsh ride and shortened life to the suspension components will occur.

1. The proper spring tension may be obtained by having the rider(s) sit on the machine, in the normal sitting position and measure the distance between the floor and the bottom of the running board at the rear of the machine (either side). This measurement must be 4½" to 6".

2. To adjust, loosen the nuts on the eye bolts and adjust accordingly, making certain that each spring is tightened or loosened the same amount.

3. Repeat Step 1, and tighten the nuts on the eye bolts securely when the 4½" to 6" measurement is attained.

NOTE: When 300 lbs. (combined passenger weight) is normally carried on machine, a "heavy duty" spring kit should be installed on machine. This kit is available at your Scorpion Distributor as an accessory item.

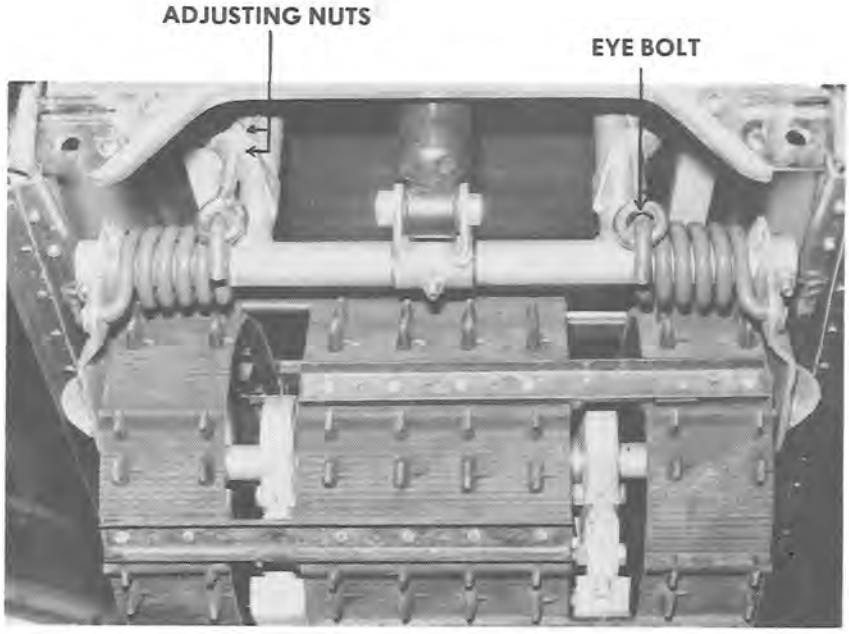


FIG. 5-25

TRACK TENSION ADJUSTMENT

Proper track tension is extremely important to assure long life of all associated components and efficiency of the track drive system.

The track tension should be checked at the following intervals:

1. When the machine is new (dealer preparation).
2. After the first 10 hours.
3. Every 30 days, or 200 miles of operation.
4. At the start of each snow season.

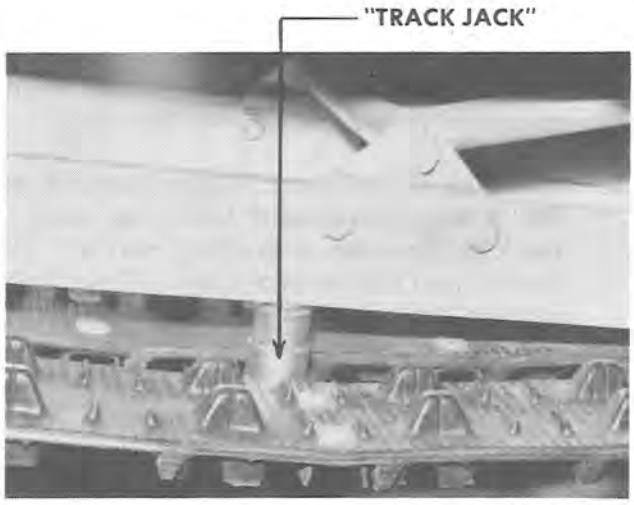


FIG. 5-26

The following procedure applies to all "Para-Slide"T.M. equipped Scorpion snowmobiles:

1. The track should be at room temperature or should have been recently run to remove any stiffness, caused by cold weather.
2. Elevate the rear of the machine.
3. Set the "Track Jack" at 1½" and add a 3/8" shim underneath it.
4. Insert the "Track Jacks" (with shims) between the slide rail runners and the track cleats about midpoint in the flat span of the rails.
5. If the track is properly tensioned, the green ring should be just visible or aligned with the lip of the cylinder. Adjustment is required if the green ring is not visible, or is above the lip of the cylinder.
6. To make adjustment, loosen the lock nuts on the track adjustment bolts, as well as the rear suspension mounting screws (rear of tunnel just below seat), and either tighten or loosen the adjustment bolts until proper adjustment is measured on both "Track Jacks" (green ring aligned with lip on cylinder).
7. Retighten the lock nuts on the track adjustment bolts, as well as the rear suspension mounting screws.

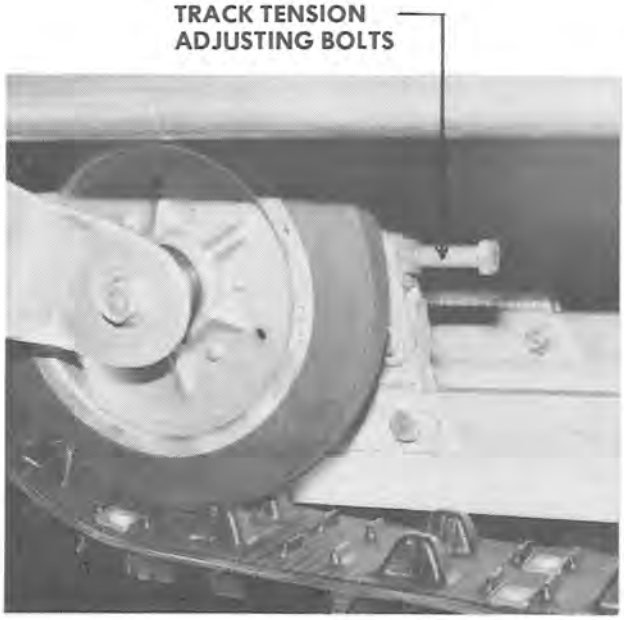


FIG. 5-26

NOTE: "Track Jacks" are available at your Scoprion Dealer. They are accessory items.

In the event "Track Jacks" are not available the following procedure may be employed to obtain proper track tension:

1. The track should be at room temperature or should have been recently run to remove any stiffness, caused by cold weather.

2. Elevate the rear of the machine.

3. Apply ten (10) lbs. of force or weight evenly distributed across the track approximately midpoint in the flat span of the rails.

4. To make adjustment, loosen the lock nuts on the track adjustment bolts, as well as the rear suspension mounting screws (rear of tunnel just below seat), and either tighten or loosen the adjustment bolts to achieve 1 7/8 inches between the top of the track cleats and the bottom of the slide runners at midpoint in the flat span.

5. Remove ten (10) lbs. force or weight and retighten the lock nuts on the track adjustment bolts, as well as the rear suspension mounting screws.